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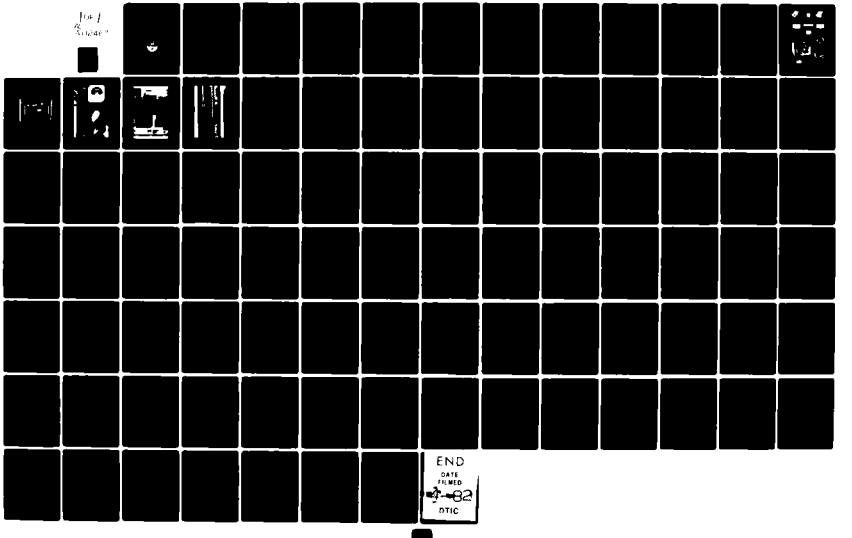

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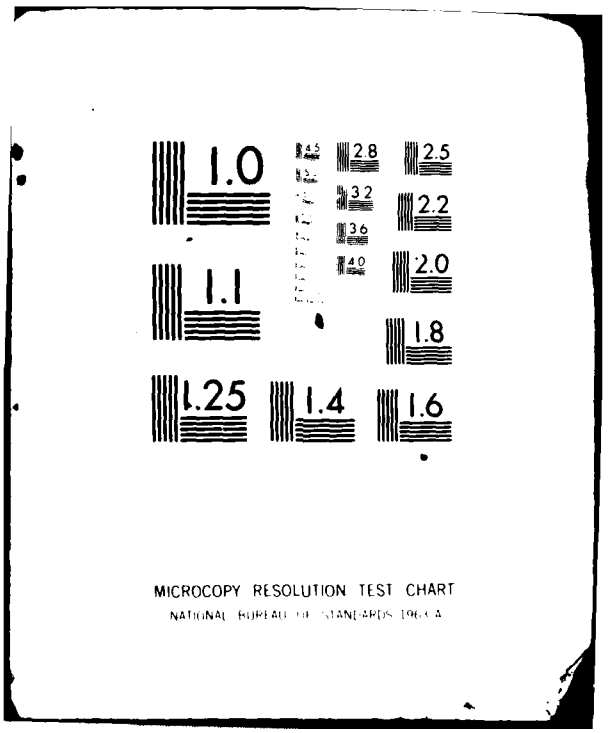
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GENERALIZED MAINTENANCE TRAINER SIMULATOR: USER MANUAL

NAVY PERSONNEL RESEARCH
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GENERALIZED MAINTENANCE TRAINER SIMULATOR: USER MANUAL

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This manual has been prepared to support preparation of lessonware (data bases) for the Generalized Maintenance Trainer Simulator (GMTS). The GMTS is capable of providing interactive simulation of function for a wide variety of equipments. The manual outlines the process of developing images of the equipment being simulated to depict equipment states (indicators, switch settings, test equipment readings, etc.) and an alphanumeric data base that controls access to each image. Experience with the trainer

indicates a high degree of transfer to real equipment maintenance. The GMTS is the precursor to Unit 1 of the Electronic Equipment Maintenance Training System (EEMT, Device 11B106). This manual therefore provides a description of both the GMTS and the functional characteristics of the EEMT.

FOREWORD

The Generalized Maintenance Training Simulator (GMTS) described herein was developed under Project ZO789-PN.01 (Class "A" Electronic Equipment Maintenance Training System). Its mission sponsor was the Chief of Naval Operations (OP-01); appropriation sponsor, the Chief of Naval Operations (OP-98); and acquisition sponsor, the Chief of Naval Material (MAT-08E1). The objective of the subproject was to demonstrate the concept of a training simulator having broad application in the field of electronic maintenance training systems.

GMTS is the end product of research on maintenance training initially sponsored by the Office of Naval Research and is the forerunner to Unit 1 of the Electronic Equipment Maintenance Training (EEMT) System. The functional relationships within the equipment remain the same, although the hardware is significantly different. Therefore, this manual can be used with both EEMT and GMTS.

This is the seventh report concerning GMTS or EEMT. Two of these reports described the field evaluation of and hardware/software development for GMTS (NPRDC TRs 80-30 and 81-9). Results demonstrated that (1) the GMTS concept can be successfully implemented with essentially off-the-shelf hardware components, (2) the development of data bases is within the capabilities of subject matter experts having knowledge of the equipment, and (3) students learn about as well using the trainer/simulator as when using actual equipment in the training environment. Three others described EEMT concept evaluation, EEMT system definition, and a Device Test and Evaluation Master Plan for EEMT (NPRDC TN 79-3, TR 81-11, and SR 81-19). The purpose of the sixth report (NPRDC TN 82-6) was to introduce the GMTS concept to Navy schools and school administrators and to serve as a precursor to more specific data on the design and performance of GMTS in the schools.

Acknowledgment of the contributions of the late Dr. Joseph Rigney, Behavioral Technology Laboratories (BTL), University of Southern California (USC), who contributed to the development of the trainer/simulator concept, and of Dr. Douglas M. Towne, BTL, who carried the development forward, is hereby extended. Appreciation is also extended to members of the BTL staff, whose contributions were essential to system development. We wish also to acknowledge the continued support of the Chief of Naval Technical Training, and personnel of the Advanced Electronics Schools Department, Service School Command, San Diego.

JAMES F. KELLY, JR.
Commanding Officer

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Technical Director

SUMMARY

Problem

The operational and maintenance skills needed by electronics technicians cannot be acquired without extensive training and practice in the use of the appropriate equipment. However, training that must depend on the use of actual equipment is expensive, involves hazards to personnel and equipment, and requires time-consuming procedures such as insertion of faults and conversion maintenance. Moreover, actual equipment is often in short supply and delivery of training units to schools on a timely basis is not always possible. As a result, training is often accomplished on inappropriate or obsolete equipment or is bottlenecked by the lack of available equipment. A low-cost, image-based trainer capable of simulating the operation and maintenance functions of a wide variety of electronic equipments could alleviate many of the problems inherent in the use of actual equipment.

Purpose

The purpose of this manual is to support the development of data bases for use on image-based, computer-controlled trainer simulators of the type represented by the Generalized Maintenance Trainer Simulator (GMTS) and Unit 1 of the Electronic Equipment Maintenance Trainer (EEMT), Device No. 11B106.

General Description

The GMTS is the development model for an interactive, image-based, computer-controlled trainer simulator capable of simulating a wide variety of electronic and electromechanical equipments. The trainer simulator uses photographic images of equipments to simulate their operational characteristics and provide effective training practice. The GMTS is the forerunner of the EEMT 2D trainer, which the Navy expects to have in its inventory in FY 1982. Both units consist of off-the-shelf components mounted in a single student desk. The GMTS components include the computer (a TERAK Model 8510), a touch-pen (Graf-pen), and a Bruning 95 microfiche projector modified for computer control.

Implementation

The implementation of this training technology requires development of both the photographic images and the alphanumeric data base that describe the equipment states to be simulated. The alphanumeric data base controls access to the equipment images. The images required include top level, intermediate, and scene level images, plus images of test equipment readings. Scenes depict the equipment simulated by displaying switch settings and indicator readings. This report describes the process of developing and checking out data bases, as well as the operation of the trainer in the training environment.

CONTENTS

LIST OF FIGURES

INTRODUCTION

Problem

The operational and maintenance skills needed by electronics technicians cannot be acquired without extensive training and practice in the use of the appropriate equipment. However, training that must depend on the use of actual equipment is expensive, involves hazards to personnel and equipment, and requires time-consuming procedures such as insertion of faults and conversion maintenance. Moreover, actual equipment is often in short supply and delivery of training units to schools on a timely basis is not always possible. As a result, training is often accomplished on inappropriate or obsolete equipment or is bottlenecked by the lack of available equipment. A low-cost, image-based trainer capable of simulating the operation and maintenance functions of a wide variety of electronic equipments could alleviate many of the problems inherent in the use of actual equipment.

Purpose of Generalized Maintenance Trainer Simulator (GMTS)

The Generalized Maintenance Trainer Simulator (GMTS) is the development model for an interactive, image-based, computer-controlled system for providing technicians with practice in troubleshooting electronic and electromechanical equipments. The function of the GMTS is to demonstrate the technology and practical use of the system concept and to facilitate the development of specifications and data for the design of the software that will run the trainer simulator. The prototype version of the trainer simulator, Unit 1 of the Electronic Equipment Maintenance Training System (EEMT), Device 11B106, as well as the production version, are expected to function identically to the GMTS. The essential differences will be in the hardware selected for the implementation and in those improvements effected during implementation. Except for details regarding the hardware, the contents of this manual are expected to apply to both devices.

Unlike "conventional" simulators, which are built to simulate some particular equipment, the GMTS and EEMT are capable of simulating the characteristics of a wide range of equipments and systems and of presenting performance symptoms identical to those of real equipment during either normal or failed operating conditions. Students change control settings for the simulated equipment, observe the responses obtained, take test equipment readings, and ultimately are able to identify and replace any element that is causing abnormal symptoms. Preliminary data indicate that students learn just about as effectively using the trainer as they do when using actual equipment.

Generalizability of the trainer simulator is accomplished by developing a set of photographic images arranged in a prescribed hierarchical structure, plus an alphanumeric data base that controls image presentation. Figure 1 illustrates the hierarchical structure of the data bases. The images must include a top level image, intermediate and scene level images, plus images reflecting test equipment readings. The hierarchy may contain up to 10 levels of images, although that many levels are rarely needed. The hierarchical structure is best illustrated with an actual example: Figure 2 shows the top level system image for the AN/WSC-3 (Echo) simulation used in a recent system evaluation; and Figure 3, an equipment level image. Figure 4 is a front panel scene accessed directly from the equipment level image. Figure 5 is the top view of the unit, which is also accessed from the equipment level image, and Figure 6 is a scene accessed from that top view.

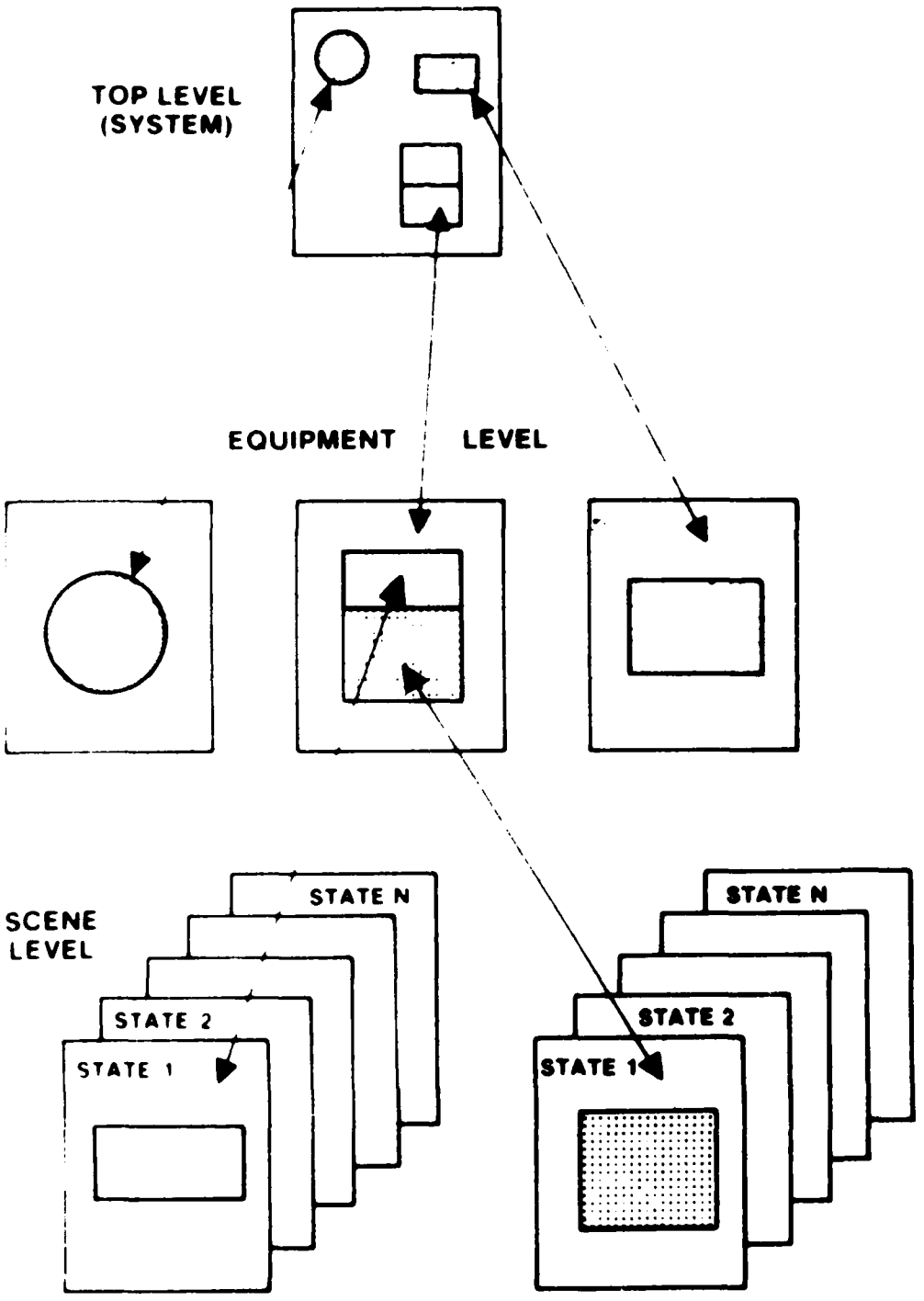

Figure 1. Hierarchical system representation.

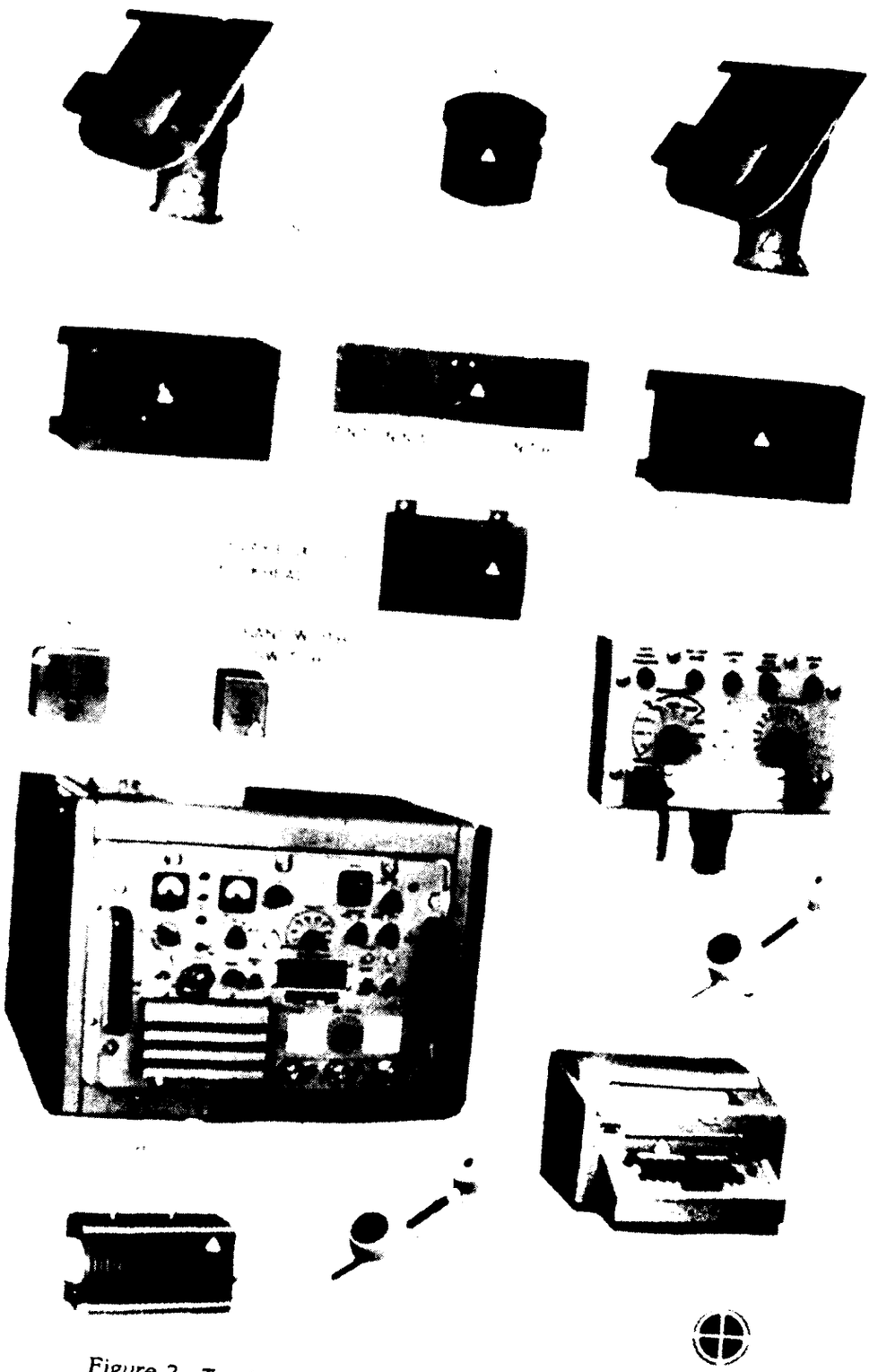

Figure 2. Top level image, AN/WSC-3 data base.

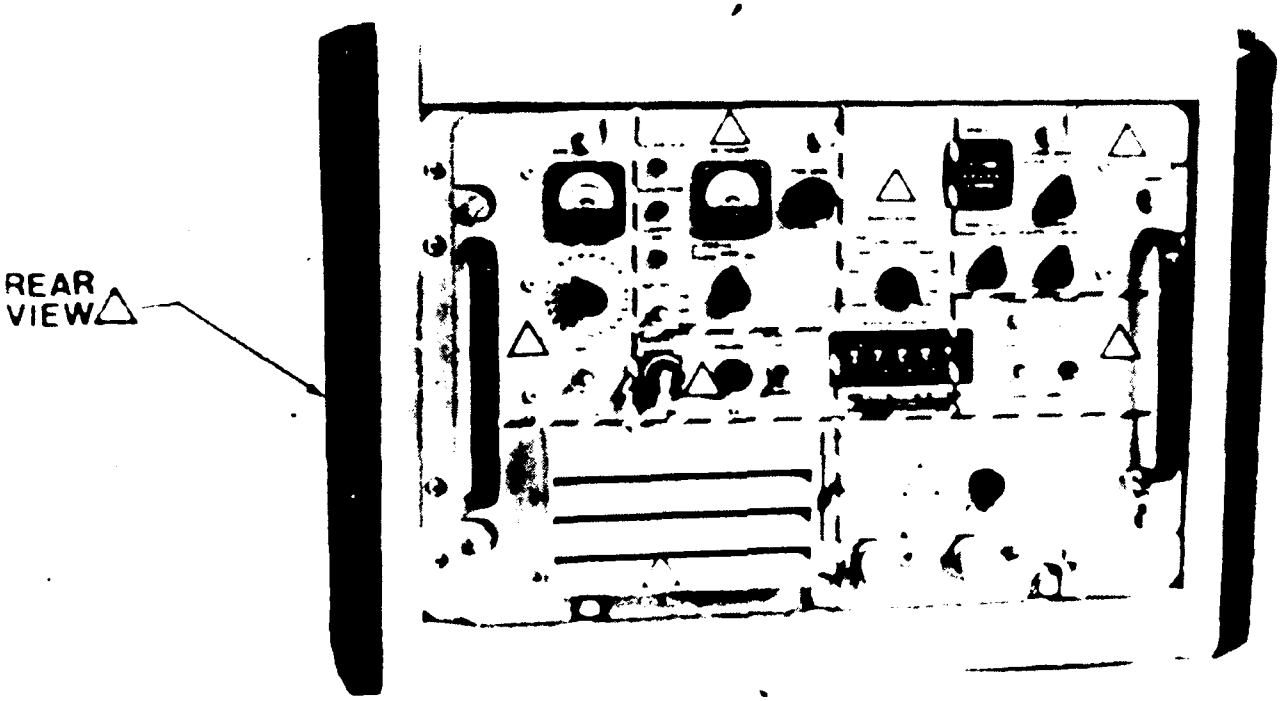

Figure 3. Intermediate level image, AN/WSC-3 data base.

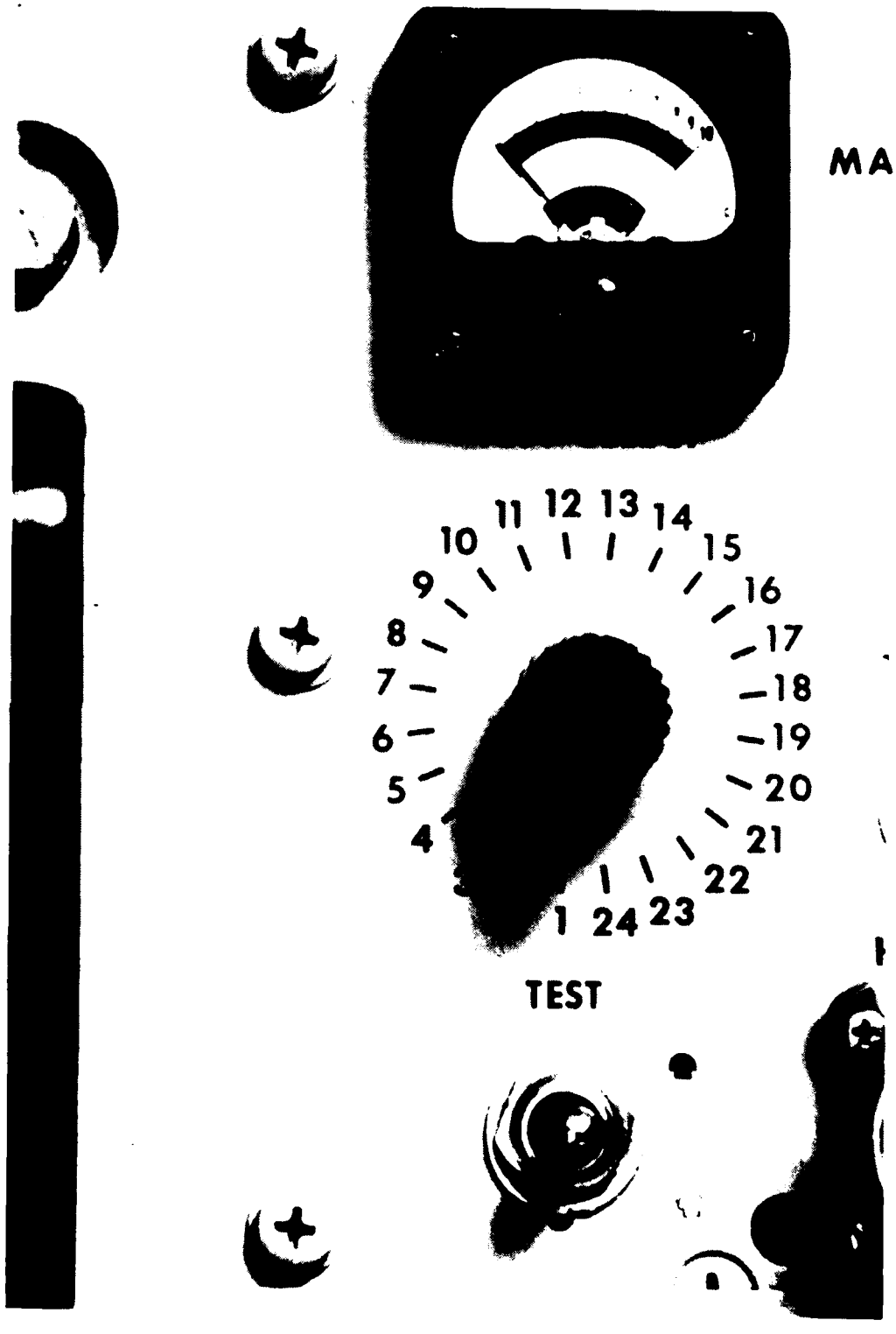

Figure 4. Scene level image, AN/WSC-3 data base.

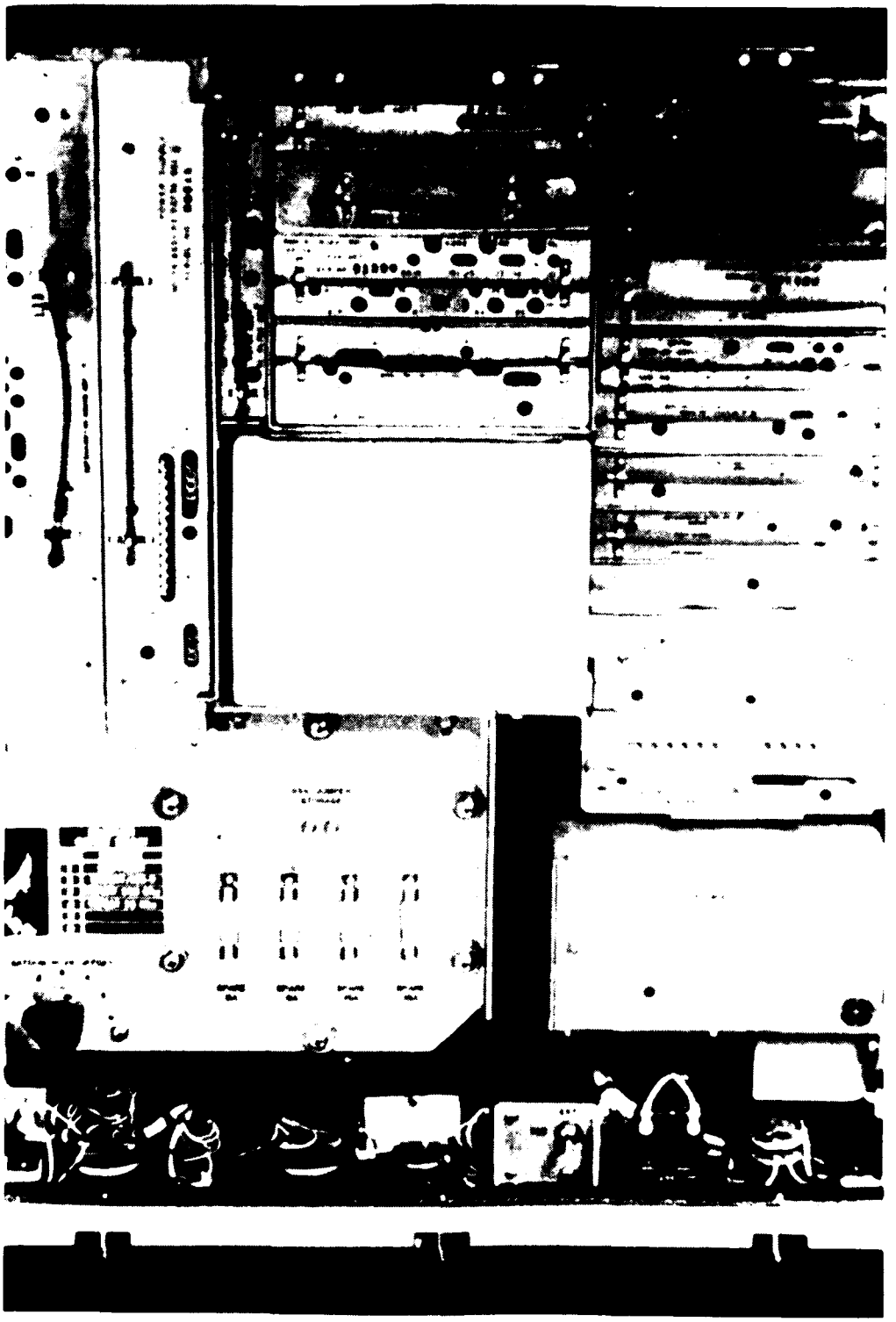

Figure 5. Top level view, AN/WSC-3 data base.

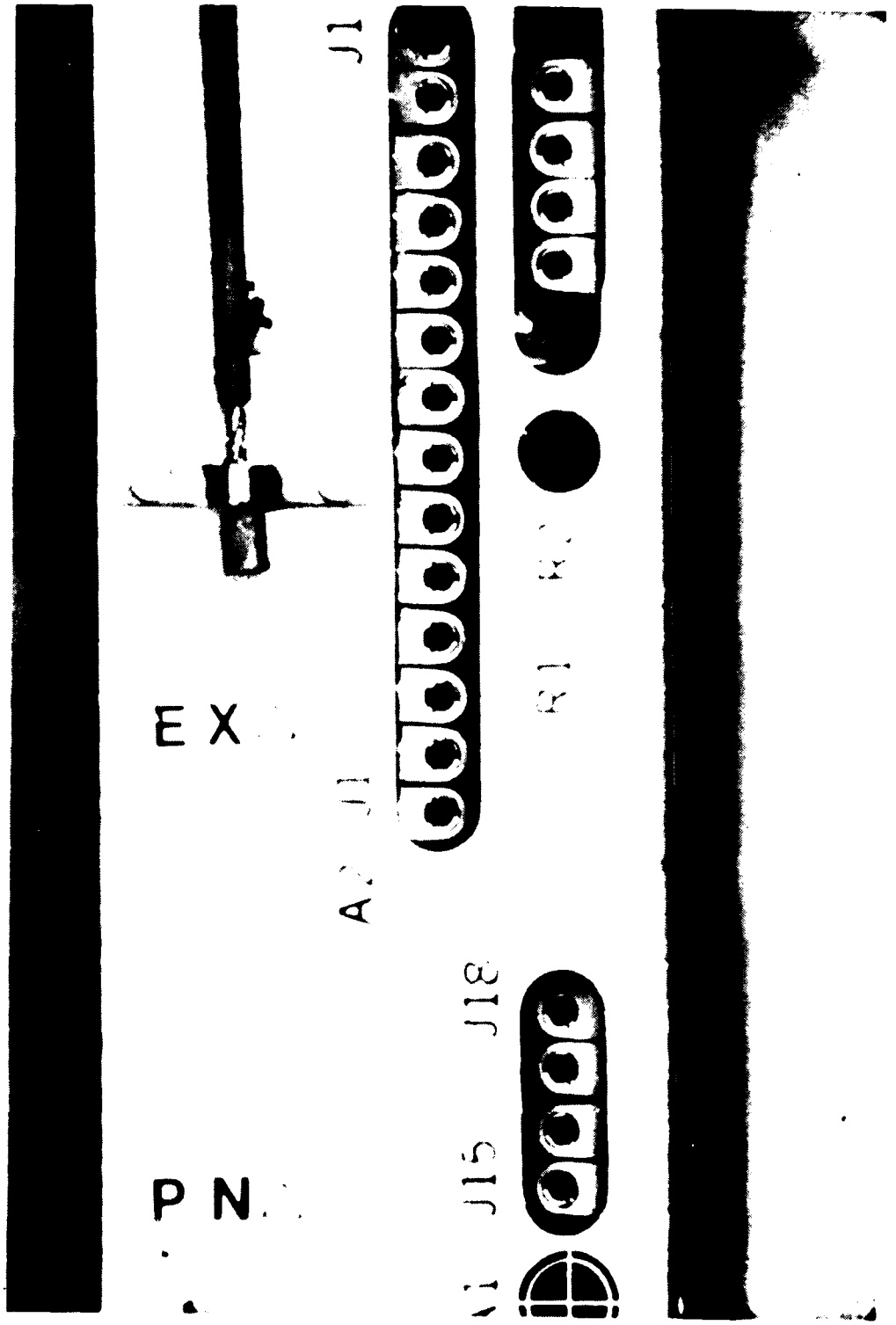

Figure 6. Module level scene, AN/WSC-3 data base.

All simulations start with presentation of the top level image. The student then interactively selects intermediate and scene level images as necessary to observe the symptoms that identify the state of the equipment. He manipulates switches to turn on the equipment and control the equipment state, reads equipment indicators that identify the states, and takes measurements, using simulated test equipment. Practice and/or test problems are solved by symbolic replacement of faulty components of the system.

The trainer simulator keeps track of all student actions, notes the conditions established by switch settings and equipment malfunctions, and presents images that accurately reflect the system state.

Objectives and Use of this Manual

This document has been prepared to support preparation of data bases for new simulations. It necessarily describes the current implementation; that is, the GMTS implementation. Data for the prototype and production models of the trainer simulator will be provided at a later date. The function of this manual is to describe the data base development process and to present, in some detail, the functions that must take place prior to and in connection with the use of the trainer simulator in a training environment. Individuals planning to use the trainer simulator should make it a point to read through this manual thoroughly before attempting to institute its use in their programs.

GENERAL DESCRIPTION: GMTS

General Equipment Description

GMTS consists of three major units packaged into one integrated station:

1. A microcomputer system with disk drives, a cathode ray tube (CRT), and keyboard.

2. A computer-controlled microfiche retrieval and projection unit.

3. A touch-pen system, consisting of a pen-like stylus, two sensors, and an electronic control unit.

The external features of the trainer/simulator are shown in Figure 7.

The specific subsystems employed in the GMTS are as follows:

1. A Terak computer, consisting of (a) an 8510a microprocessor (CPU and RAM), with disk drive, (b) an 8512 disk drive, (c) a CRT, and (d) a keyboard (used only by instructor and data base preparer).

2. A Bruning Model 95 microfiche retrieval and projection system with RS-232 interface.

3. A Science Accessories Corporation Graf-pen, consisting of (a) a stylus, (b) two acoustic sensors mounted on the front panel of the trainer, and (c) an NT201 control unit with RS-232 interface.

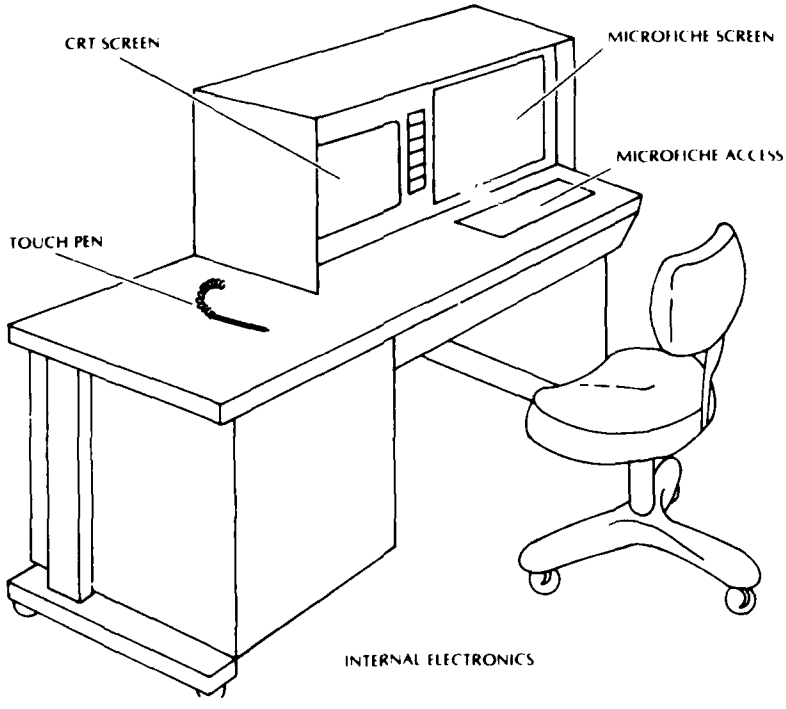

Figure 7. Rigney trainer (GMTS).

Student Interaction

During a training session, the student uses the touch-pen to touch the CRT, the image display screen, or a list of command words (called the command "menu") placed between the CRT screen and image display screen. The trainer responds by displaying a new question or statement on the CRT or by projecting a new image on the image display screen. Simulation of the real equipment and test equipment is accomplished entirely via the presentation of color images shown on the image display screen. Messages and questions for the student about the training are presented exclusively on the CRT screen.

Generally, touching the CRT (as when touching the answer to a question) will produce a response on the CRT virtually instantaneously (less than .05 second). Responses to command menu selections may involve the CRT and/or the image display screen. CRT responses to menu selections also appear virtually instantaneously. The GMTS time to complete the retrieval and projection of a new image is approximately 1 second if the new image is on the same fiche as the previous image, and approximately 3 seconds if a fiche change is required.

Responses to inputs on the image display screen will, however, involve a short compute delay in addition to the image change time described above. The compute delay

varies from less than 1 second to as much as 5 seconds with an average of approximately 1 second. The compute delay will vary from one data base to another and from one situation to another within a single data base. It is a function of the number of images requiring evaluation prior to selection.

Simulation Capabilities and Limitations

Simulation is achieved using high-resolution color images of the equipment being simulated. Simulation of equipment status is thus limited primarily to static, visual representations. Variations in states cannot be presented dynamically, nor is audio simulation possible. Audio and dynamic symptoms can, however, be represented visually in ways described in the section on developing new simulations (under step 5, p. 16).

Changes in switch settings and in indicator readings are shown by changing the images presented on the image display screen. Each action of the student as he touches the image display screen results in presentation of a new image in which the altered equipment state is shown. Persistence of states is controlled as follows:

1. Switch settings persist until changed by the student. This includes spring-loaded switches that must be explicitly released.

2. Symptoms (both normal and abnormal) persist until the student alters the simulated equipment in a way that would alter the symptom. These ways include "replacing" a faulty element (via a REPLACE command) or symbolically changing switch settings or connecting and disconnecting simulated test equipment.

The Bruning 95 has a limitation of 1800 images (30 fiche, 60 images per fiche). This is usually sufficient for the simulation. However, if a data base with a greater number of images is required, the simulation can be created in segments, each having up to 1800 images.

Creation of the data base that controls the simulation is accomplished at the instructor terminal described below. The process is described in detail in later chapters.

Malfunction Simulation

The system can simulate any malfunction that exhibits its symptoms in a consistent fashion (intermittent faults are not permissible) and is correctable by replacement of a single unit or component. The effects of multiple, simultaneous faults can be simulated, but there is no provision for making simultaneous replacements. Replacement of the "key" element used to present the multiple-failure symptoms will "solve the problem." The use of multiple-failure problems is therefore contraindicated.

Operating Parameters

The GMTS is designed to operate in normal land-based training environments. The nominal power, temperature, and humidity requirements are as follows:

1. Power: 115/120 VAC, 60 Hz.
2. Power Consumption: 760 watts.
3. Operating Temperature: +40 to +90 F.
4. Humidity Range: 20% to 80% R.H.

Personnel Considerations

The GMTS presents no safety hazards to the student in its normal operating configuration. The high voltages present at the CRT are fully enclosed and inaccessible during training.

Instructor Station

Each GMTS has the capacity to become an instructor terminal by adding a keyboard and printer to the system. The keyboard is used to develop data bases, initialize student discs, establish problem sets, and manage data. The printer is used to edit data bases and to collect student data.

TRAINING OBJECTIVES

Specific training objectives will vary greatly from one application of the trainer to another. The general training objectives for which the system was designed are as follows:

1. To become proficient in determining the state of the real equipment. States used for training include equipment operating normally, within normal tolerances and operating limits, and equipment not fully operational by reason of malfunctions.

2. To become proficient in setting up and interpreting front panel tests. This shall include attaining modes of operation that specifically require, or specifically avoid, various internal functions, and interpreting the normality of indications exhibited in these modes.

3. To become proficient in identifying elements or sets of elements thought to be functioning normally and those considered as possible causes of abnormal performance.

4. To become proficient in the use of test equipment to obtain information not available at the front panel. Proficiency includes selecting test equipment, selecting test points that will reveal the states of the prime equipment, and interpreting the indications obtained.

The trainer/simulator is capable of providing training exercises that vary greatly from one malfunction to another within individual systems and from one target system to another. Since it also must present the simulated system in its normal operating condition, exercises can be devised to familiarize the technician with normal indications and responses.

Troubleshooting exercises start with a statement regarding the indicated fault. The student then works through the exercise following normal troubleshooting procedures, using test equipment as required. Normally, such exercises conclude with a replacement of the failed unit. The trainer/simulator will function in both a training and test mode. Helps provided during training are inaccessible during test mode.

DEVELOPING NEW SIMULATIONS

The process of implementing a new simulation consists of well-defined steps, each with an associated deliverable product. These products can be used as milestones for scheduling and project monitoring. The steps can be summarized under the following headings:

Step 1: Define Scope of the Training/Simulation (System Analysis)
Step 2: Analyze Training Requirements
Step 3: Define the Simulation
Step 4: Establish Switch List
Step 5: Establish Picture List
Step 6: Establish Test Point List
Step 7: Establish Test Equipment Picture List
Step 8: Develop the Alphanumeric Data Base
Step 9: Enter the Data Base
Step 10: Take Photographs
Step 11: Enter X-Y Data
Step 12: Checkout

Each of the steps is described below. Additional data are provided in those chapters that relate specifically to some of the steps outlined.

Step 1: Define Scope of the Training/Simulation (System Analysis)

This step consists of three tasks: (1) identify the system to be simulated and the major elements of the system to be included in the simulation, (2) prepare a complete list of the equipment, including any associated test equipment, and (3) list the major modes of operation to be simulated.

In defining the operating modes that the simulation will cover, the data base preparer has an early opportunity to limit the amount of work to follow. An effort can be made at this time to eliminate redundant modes that in no way enhance the simulation. For example, consider an equipment that operates in 20 frequency bands divided into two banks of 10 bands each, in which the two banks are identical in structure and wherein bands 3 to 10 and 13 to 20 are essentially redundant copies of bands 1, 2, 11, and 12. That equipment can be simulated and problems isolated by using only four bands: 1, 2, 11, and 12. This reduction in modes will greatly reduce data base volume.

Step 2: Analyze Training Requirements

This step consists of two tasks: (1) define the prerequisite skills of entering students, the terminal training objectives, and the malfunctions to be simulated, and (2) specify the level to which maintenance is to be performed (i.e., will modules, boards, or components be replaced?).

Careful consideration should be given to the maintenance/replacement level philosophy of the simulated equipment. It impacts the depth to which the simulation must be carried, and the selection of effective practice problems. Because malfunction data can be added to an existing data base, it is not critical to spend extensive time to project a complete list of problems. Note, however, that malfunctions that cannot be isolated with the originally-defined images, test points, and test equipment may require extensive revision to the data base.

Step 3: Define the Simulation

The system elements defined by Step 1 form a first level of subdivision of the entire system or equipment. These elements may need to be further subdivided before defining the scene level of the equipment, the level at which the simulation takes place. Then, the scenes need to be defined.

In defining the simulation, it is important to make logical divisions of the system at both the intermediate and scene levels, both for learning purposes and because the decisions made directly affect the size and complexity of the data base. Switch settings and indicator readings are altered only at the scene level, not at the equipment or system level. Therefore, the top level and intermediate level (equipment) views present only one image. Scenes, on the other hand, will require one or more images, because they must show all of the possible combinations of switch settings and indicators in the scene. The number of images needed is a direct function of how the data base preparer defines their content. For example, a scene containing a two-position switch, a four-position switch, a light (two conditions, on or off), and a meter that is to be shown in any of three positions, requires 2 x 4 x 2 x 3 or 48 separate images to depict all possible combinations. Should the data base preparer decide to include another switch having perhaps 10 positions, the number of images needed would soar to 480. For that reason, the scene would probably not be defined to include that combination of items.

There are several ways to keep the number of images needed, and therefore the size and complexity of the data base, within reason. The first is obviously to define scenes that have only a few switches and indicators. The scene definitions shown in Figure 3 provide a good example. They are logical both as to the number of images required and as to their effectiveness in training. The second way to limit the size of the data base is to eliminate redundant or uninstructive modes, as was suggested under Step 1. The process can be, and often is, an iterative one in which scene definitions and simulation scope change as their relative merits are evaluated.

Scenes, in addition to presenting switches and indicators that vary according to system state, also provide access to test points and subscenes. Subscenes, which are assigned their own scene numbers, are used for such things as providing a different view, showing a section with its cover removed, zeroing in on a particular component, etc. For example, the touch point designated "PN" in Figure 6 is a subscene that provides access to pin connections for the module.

Subdividing the equipment into different levels and scenes is arbitrary in the sense that the simulator can accommodate any plan. However, the data base preparer should plan subdivisions that follow natural physical and functional characteristics of the equipment. The data base should let the student access an area of interest with as few changes in level as possible and should present images that are congruent in function and meaning.

During training, the computer keeps track of the sequence of images accessed at up to ten different levels. The appropriate image numbers are placed in a stack as the student goes through the simulation. As he goes back through the simulation, the computer downloads image numbers from this stack to bring back the appropriate intermediate level images. In complex systems requiring multiple levels, the data base preparer may have to plan around this limitation. However, this is usually not a problem. Most simulations require no more than four to six levels.

All views of the equipment, top level, intermediate level, and scenes must be assigned unique identifying numbers, starting with 1 and continuing without omissions until all views have been "defined" by number. The top level image is always assigned No. 1. The numbers of intermediate views and scenes should then be assigned in some logical fashion. For convenience, it is often very helpful to have sequential numbers for views selected on a particular image. Since the top level view is No. 1, equipment level view numbers might start with No. 2 and continue until all equipments have been defined. Each subscene on a particular equipment would then be numbered in some logical sequence. In the data base description, you will find that views are identified by "scene" numbers. References to scene numbers in this manual therefore may be a reference to a defined scene or to an assigned number. The context should make the meaning clear.

The defined scope of the simulation governs the amount of labor required for data base preparation, the number of images to be photographed, and the number of equipment states to be defined. In the GMTS, a maximum of 1,800 images (60 images on 30 fiche) is available in a microfiche cassette. If this number of images is insufficient to present an entire system, it is necessary to (1) break the system into major parts, each simulated separately, or (2) redefine the simulation to reduce the number of images required (fewer switches in critical scenes or fewer states simulated).

Step 4: Establish Switch List

The switch list lists all switches used in the simulation and those system devices, such as dummy loads and test equipments, that can affect the state of the equipment. The switch list starts with the number "1" and continues without omission. Switch numbers should be assigned in some logical order. Switches or other devices not used in the simulation are not numbered.

Continuous controls that are necessary elements of the simulation must be defined as "switches" having finite settings. Further, if there are not distinct markings on the control, the switch and the front panel must be somehow marked during photography so available settings are easily recognized for selection by the student. Some continuous controls, while necessary to the operation of the prime equipment, do not significantly alter signals or the internal signal paths employed and may be of minimal instructive importance. Focus and fine tuning controls may often be omitted entirely from the simulation.

Switch settings must be numbered from 1 to the number of settings available. The number "0" may NOT be used as a specific switch position. The number "0" is used throughout the data base to mean "any condition." It is reserved, with respect to switch positions, for identifying, in section 11, those problems wherein all switches are set to the default setting. In section 12 of the data base, omitting the switch number has the effect of indicating that any setting of the omitted switch is satisfactory. The usual case is that a great number of switches will be irrelevant to a great many conditions.

Since the state of the system is determined by the current settings of the switches, it is necessary to define everything that affects the system state as a switch. Thus, certain types of test equipment that affect signal flow, such as signal generators and dummy loads, must be treated as switches. For example, the dummy load in a transceiver system could be defined as a switch with the switch positions (1) DISCONNECT and (2) CONNECT. This allows its effect upon the system to be evaluated and presented.

Step 5: Establish Picture List

The photographs needed for the system data base are made from a picture list. The picture list must identify the top level, intermediate level, and all of the scene level images needed for the simulation.

The different combinations of switch settings and indicator readings required for each scene must be enumerated for each state of the equipment. A convenient way to accomplish this is to prepare a picture matrix for each scene. The picture list needed in the data base is derived from the list of equipments and intermediate views and the sum of these matrices. The matrices form a starting point for the entire data base, since they show both the images required and the conditions for displaying each image. A sample matrix is presented in Figure 8.

			Power Switch Condition							
			OFF				ON			
			Mode Switch				Mode Switch			
		Power Light	1	2	3	4	1	2	3	4
Meter Readings	Zero	OFF	211	212	213	214	215	216	217	218
		ON	--	--	--	--	219	220	221	222
	Red	OFF	--	--	--	--	223	224	225	226
		ON	--	--	--	--	227	228	229	230
	Green	OFF	--	--	--	--	231	232	233	234
		ON	--	--	--	--	235	236	237	238

Notes.

1. Picture No. 213 = fiche 02, image 13 (first image in row B).
2. Redundant images are omitted.

Figure 8. Sample picture matrix.

The numbers placed in the picture matrices are the numbers of the images of the microfiche image to be presented (GMTS; frame numbers for the EEMT). As noted in the chapter on photography, the numbers identify the fiche (first two digits) and the image on the fiche (last two numbers). Images for a single scene should be grouped together on the same fiche. Also, it is good practice to assign fiche numbers according to a logical selection sequence, in order to minimize the number of fiche changes.

Each microfiche has provisions for 60 images arranged in 5 rows (A-E) of 12 columns, as shown below:

	COLUMNS											
	1	2	3	4	5	6	7	8	9	10	11	12
ROWS												
A	01	02	03	04	05	06	07	08	09	10	11	12
B	13	14	15	16	17	18	19	20	21	22	23	24
C	25	26	27	28	29	30	31	32	33	34	35	36
D	37	38	39	40	41	42	43	44	45	46	47	48
E	49	50	51	52	53	54	55	56	57	58	59	60

The first image on each microfiche (Row A, Column 1) must be the overall system scene. Although spacing between images on a fiche should be avoided, it may be desirable to leave several blanks at the end of each fiche to cover additions. The title of each microfiche should describe the scenes depicted.

An important consideration related to simulation is the treatment of nonvisual symptoms, such as audio indications. Usually, audio symptoms may be visually represented in a drawing. For example, a radio handset could be shown with a cartoonist's balloon containing words such as:

"Your transmission was garbled."
"...your transmission was fine."
"...(garbled reception)..."

Nonverbal sounds can be similarly represented as:

...a steady 60Hz tone
...a weak, varying buzz
...a soft fan sound
...a grating sound

Words may also have to reveal the normality of the indication such as:

...a normal high-pitched tone
...an abnormally weak signal

Step 6: Establish Test Point List

The test point list must include every test point to be used in the simulation. As for all other lists, the test point list begins at "1" and continues to the highest number needed, without omissions.

Step 7: Establish Test Equipment Picture List

The GMTS uses pictures of test equipment readings to indicate what the test equipment would read at the test point selected for the conditions established by the selected switch settings and the problem situation. Two approaches are possible: (1) direct reading; that is, the student is given a reading representing a properly adjusted setting, or (2) indirect reading; that is, the student first adjusts the equipment and then

gets an appropriate reading. The picture list used for the second approach, adjusting the equipment, must be an integral part of the data base (the test equipment must be assigned specific scene numbers). Note that adding this facility can significantly expand the data base, because many more images of readings will be needed. The picture list for readings is established much like the picture list for scenes. A sample test equipment matrix is presented in Figure 9.

	Mode Switch			
CONDITION	1	2	3	4
Power off	843	--	--	--
Normal Operations	844	845	846	847
Problem # 1	--	--	--	--
Problem # 2	848	--	849	850

Notes.

1. Picture No. 843 = fiche 08, image 43 (7th image in row D).

2. Redundant images are omitted.

Figure 9. Sample test equipment picture matrix.

Step 8: Develop the Alphanumeric Data Base

Each simulated problem must deal with two situations: (1) equipment malfunctioning due to the fault that exists, and (2) equipment operating normally after replacement of the failed component. Both situations must be defined in the photographic images and in the alphanumeric data base.

The alphanumeric data base assembles picture data within blocks that identify normal operating states and those that identify abnormal indications. Normal data are assembled in blocks numbered with the scene number, a period, and a "0" suffix. Abnormal data are assembled in a block identified with a number suffix. For example, block 2.0 contains normal data for scene 2, while block 2.1, which follows block 2.0 in the data base, shows abnormal data for scene 2. The number of abnormal data blocks required for each scene depends on the number of malfunction indications to be simulated.

The first line of each block of picture data starts with the block number, a colon (:), and then the number of the first image to be evaluated (e.g., 2.3:*417). The picture number is followed on the very next line by a number indicating how many conditions are to be evaluated (see definition of conditions below). The conditions are then listed on successive lines. This pattern, asterisk, picture number, number of conditions, and conditions, is repeated for the rest of the pictures for that scene (see Appendix A for examples).

The alphanumeric data base selects images based on problem data and switch settings. Immediately after a student requests an image, the computer checks the data base to see if the prerequisite condition for viewing the particular scene requested is true. Prerequisite conditions may be based on such system characteristics as lockouts, trigger guards that must be lifted, etc. A prerequisite condition must be listed for each scene. It can be "0" (any condition). It is placed in a special section of the data base.

After checking for the prerequisite condition, the computer checks to see which image of the scene is to be presented. The data base enumerates, in terms of switch settings (one or more) for one or more switches, the conditions under which each image may be shown. Pictures (images) are shown only if the conditions specified are true. Images are checked in the order in which they are listed in the data base. The images listed in abnormal blocks will be checked first, followed by the images in the normal block, except, of course, when the operating conditions are normal. If the first condition listed under a picture is "true," and there is only one condition listed, the picture will be shown. No additional pictures will be evaluated. If the first condition is true and there are two or more conditions listed, the computer will check to see if at least one more of the succeeding conditions is also "true." If not, the computer goes on to the next picture in the list and evaluates its conditions.

The conditions for pictures listed first will be evaluated first. If the conditions for a picture early in the list are found to be true, that picture will be shown, and the conditions for the following pictures will not be evaluated. Because an image must be shown once the prerequisite condition has been satisfied, a "default" picture must be included at the "end" of the picture list. The default picture must be at the end of the normal data block, since the computer searches the normal block if it exhausts all possible pictures in an abnormal block without finding the appropriate image to show. The default picture may have "0" (any condition) as a sufficiency condition, or it can have a condition that finally exhausts all the possible conditions for showing the scene in question. If neither of these "conditions" is met, a data base error will occur.

In developing the data base, normal operations should be defined first, as this will account for the majority of the images needed. Separate and early development of the normal data also makes data base checkout significantly easier.

Step 9: Enter the Data Base

The data base is keyed in at a trainer station and recorded on a diskette. Separate utility programs are then used to (1) check data format for obvious omissions and contradictions and reformat the data in machine-readable form, and (2) check out data base content.

Specific information on data base format and on data entry and checkout is contained in the next two sections.

Step 10: Take Photographs

With the picture list in hand, individual color photographs are made for each image including the top level, intermediate, scene, and test equipment reading images.

When shooting scenes requiring several images to show state changes, it is mandatory to shoot them all at once, in order to have consistent registration and color in the images.

Photographs may be taken either during or after completion of the alphanumeric data base. The advantage of waiting is to assure accuracy and completeness of the data base and minimize reshooting. Accuracy and completeness are evaluated using the data check program, DATACK.

Step 11: Enter X-Y Data

Once the alphanumeric data base has been checked out and the pictures taken and reproduced, a utility program is executed to identify the locations of all touch points and store the information in the computer. The X-Y data are input by identifying and touching each "active" point in one version of each scene.

The reason for photographing all images of a particular scene at the same time and without (!) moving the camera are indicated above. Touch points are based on one image. All other images of the same scene are assumed to have the same touch point registration.

Step 12: Checkout

After completing the data base, the trainer/simulator is run by the instructor to detect any errors. Errors are corrected using the same technique as was used initially to enter the data.

Once the data base has been checked out, it should be tried out with a group of typical students. Only then can the data base developer be assured of having really completed the data base.

THE ALPHANUMERIC DATA BASE

Data bases ought to be completely written out on paper before attempting to enter them at the computer terminal. The format must follow the outline presented below. Use of a loose-leaf binder in which the sections of the data base are indexed for easy access is strongly recommended. During data base development, be sure to observe the following rules:

1. Each line in the data base will be terminated by a carriage return (RETURN key), and no line may contain more than 80 characters.

2. Everything on a line following a semicolon (;) will be treated as a comment and will be ignored in creating the data file that runs the trainer. Therefore, the required data on a line must precede any semicolon, and semicolons cannot appear within a name that is part of the data base. If a semicolon is the first character on a line, that line will be ignored. This provides a useful way to annotate the data base. An example of a proper use would be to insert an annotation on the first line of the data base to indicate its function (e.g., "83; Number of scenes"). It is a good idea to annotate the data base liberally.

3. The end of a section is indicated by a slash (/) as the first character on the line following the section. The rest of the line following the slash will be ignored. This offers a second convenient way to annotate the data base, as by following the slash with the name of the section to follow. For example, the first section could end with "/Replaceable scene names" (see Appendix A). (Excerpts from the AN/WSC-3 data base

used in this chapter are also included in Appendix A, wherein the relationships between data base sections may be visualized more easily.)

4. If the first number of a line is followed immediately by a colon (:), the number is considered to be an identification number. Identification numbers represent different kinds of elements, depending on the section of data in which they appear. Identification numbers may represent replaceable scenes, complaints, test equipment, test points, switches, problems, conditions, or scenes.

5. Identification numbers within each section must start at 1 and appear in ascending numerical order with no omissions. Identification numbers that contain block numbers have a different format from most but must still start at 1.0 and appear in ascending order.

6. Blanks are used as separators for numbers. Leading blanks are permissible anywhere in the data base, and numbers may be separated by more than one blank. Blanks, however, may not be placed between an identification number and the colon following it.

7. The number "0" is reserved for "any condition." It is the condition used for presentation of top level and intermediate images and those scenes that have only one image.

8. Picture numbers are four-digit integers (GMTS), except that the leading "0" for numbers less than 1001 may be omitted. The leftmost two digits represent the fiche number (01-30); and the rightmost two digits, the image number (01-60) (e.g., picture 317 is the 17th image on fiche 3).

9. There are finite limits on the contents of data bases. The limits currently in force are presented in Table 1.

Data Base Description

The data base consists of 17 sections. Sections 1, 4, 5, 7, 8, 9, 12, 13, 14 (partial), and 16 (partial) describe normal system operation. Sections 2, 3, 6, 10, 11, 14 (partial), 15, 16 (partial), and 17 describe abnormal effects, including problem data and malfunction indications. The suggested procedure for developing the data base is to develop and check out the normal sections and then complete the remaining sections. The layout of the complete data base is contained in Appendix A.

The relationship between the various sections of the data base will be evident in the descriptions of their content. Keep in mind that there must be elements in the data base that define the system, the system states (conditions), and the problem states. These data are then used to determine which image to present in response to student input.

The scene list is not found by itself in the data base. It is, however, very much in evidence, in that it forms the basis of the organization of Section 14. The total number of scenes is available there and must agree with the number specified in section one.

Table 1

Upper Limits on Data Base Elements

Type of Element	Maximum Size
Scenes (section 14)	100
Replaceable scenes (section 2)	100
Test points (section 6)	254
Test equipment (section 5)	10
Switches (section 4)	127
Switch positions (section 4)	30
Conditions (section 12)	1,200
Number of lines of conditions (section 12)	10,000
Problems (section 10)	99
Number of abnormal blocks for one scene	100
Number of lines of normal picture data for each block of a scene	1,100
Number of lines of picture data for each abnormal block of each scene	500
Number of lines of picture data for each block of a test point	150
Number of characters in test point and test equipment names	38
Number of characters in other types of names	80
Number of defined elements (X,Y points) on one image	80
Levels of hierarchy for scenes	10

Outline

The data base sections are described below.

1. Section 1 of the data base consists of two lines of data. The first line contains the number of scenes defined in the data base; and the second, the name of the data base. The course name is constructed of from 1 to 80 printable characters, where a "printable character" is any character that can be represented by a symbol on the CRT screen. A space (' ') is a printable character. (Some characters, such as control characters, are non-printing; that is, they are not represented by any symbol. Remember that a semicolon may NOT be used as a part of a name anywhere in the data base.)

Example:

```
83; Number of Scenes
WSC-3(E) Satellite Communications Systems
/
```

2. Section 2 lists the names of those scenes that represent system elements or components that can be replaced. Each line of this section begins with a number followed by a colon and then the name of the scene the number identifies (e.g., 6: 1A1A2 Power Supply). Identifying numbers must appear in ascending sequential order with no omissions. The replacable scene name is made up of from 1 to 80 characters, excluding semicolons. Blanks are permitted after the colon (:) and before the beginning of the name. Note again that blanks are not permitted between an identifying number and the colon following it.

Example:

```
  1:  1A1A1 Radio XMTR
  2:  1A1A2 Pwr Supply; Volt. Reg.
  3:  1A1A3 RCV Phase
  ====
 21:  1A2J8 WSC-3 BACK RF CONN
  /
```

3. Section 3 is a list of the statements that are presented to the student as the operator's complaint at the beginning of a problem. These complaints are intended to represent information that an operator might give to a technician when requesting maintenance. They may be very vague, such as, "The system doesn't work," or they may be quite specific, such as, "The malfunction light stays on in standby." They are used to give the student a starting point for each problem. The same complaint may be presented at the beginning of more than one problem.

Each line of data in this section contains a number that identifies the complaint, followed immediately by a colon, followed by the complaint. Complaints are comprised of from 1 to 80 characters, excluding semicolons.

Example:

```
  1:  Malfunction light is on.
  2:  Malfunction light stays on in standby.
  3:  Transmitter will not key.
  4:  FM inoperative.
  ====
 11:  Will not transmit in PSK 75 or FSK
  /
```

(Note that, although there are 11 problem statements listed here, there are 12 problems in the AN/WSC-3 data base.)

4. Section 4 names the switches used in the data base, identifies their positions by name, and identifies the default position (the position used at the start of each problem unless overruled by the problem data, Section 11). The first line for each switch lists the identifier (numbers from 1 to the highest number used), followed by a colon, and then the switch name. Succeeding lines identify switch positions. The next switch to be identified follows. The default settings are indicated by an asterisk. Switch names may use up to 38 characters (including spaces). There may be no more than 127 switches and 1408 lines in this section of the data base.

Example:

```
  1:  Local Modulation Switch
      75 PSK
      300 PSK
      1200 PSK
      2400 PSK
      4800 PSK
      9600 PSK
      FSK
      FM
```

```
    *AM; The asterisk identifies this as the default setting.
 2: Local X Meter Key Switch
====
/
```

5. Section 5 lists the names of the test equipments whose readings are defined in the data base. Each line contains a number that identifies the test equipment, followed immediately by a colon, followed by the name of the test equipment. Test equipment names are comprised of from 1 to 38 characters, excluding semicolons. A maximum of ten test equipments may be defined.

Example:

```
 1: Oscilloscope
 2: Multimeter-DC VOLTS
 3: Multimeter-OHMS
 4: Frequency Counter; 4 TEs
 /
```

6. Section 6 names each of the test points defined in the data base. Each line contains a number that identifies the test point, followed immediately by a colon and the name of the test point. Test point names are comprised of from 1 to 38 characters, excluding semicolons. A maximum of 254 test points may be defined.

Example:

```
  1: 1A1A1 J1
  2: 1A1A1 J2
  3: 1A1A1 J3
====
245: 1A2 J5; 245 TPs
 /
```

7. Section 7 identifies the numbers of the scenes defined in the scene list that correspond to the replaceable scenes defined in Section 2. Each line contains a replaceable scene number, followed by a colon, followed by the number of the actual scene. Both replaceable and actual scene numbers are integers from 1 to 100.

Example:

```
 1: 40
 2: 41
 3: 42
====
21: 60; 21 replaceable elements defined
 /
```

8. Section 8 lists test equipment scenes for test equipments. When it is desired that the student adjust all switches and controls on test equipments, the test equipment must be defined as a scene in the data base. Touching TEST EQUIPMENT on the command menu will then cause a picture reflecting the current control settings to be shown. If no switches are to be manipulated on an item of test equipment, no scene will be required. In this case, the scene number is entered as zero. Each test equipment defined in the data base must be represented in this section by either an actual scene number or a zero.

Test equipment numbers are integers from 1 to 10. Switches and switch positions for those test equipments that are to be adjusted must be defined in Section 4.

Example:

```
1:  0
2:  0
3:  0
4:  0; 4 TEs...must be same number as in Section 5
/
```

9. Section 9 lists the test equipment that can be connected to each test point. Each line contains a test point number, followed by a colon and test equipment numbers. The numbers are separated by one or more blanks, representing the test equipment that can be connected to that test point. All of the test equipment that can be connected to a particular test point must be listed on the same line as the test point. Each test point must be represented in this section.

Example:

```
1:  1 2
2:  1 2
3:  1 2
====
245:  4; 245 TPs...only TE #4 can be connected to TP 245
/
```

10. Section 10 numbers the problems and identifies the failed scene(s) and initial complaint for each problem. Each line of the section contains a problem number, followed by a colon, the failed scene number, one or more blanks, and the complaint number. The initial complaint is the number of the complaint that is to be displayed at the beginning of the problem. The failed scene must be one of the replaceable scenes defined in Section 2. When this scene is replaced, the problem has been solved. Neither the failed scene nor the complaint needs to be unique to a problem; more than one problem may share the same failed scene and/or complaint. The failed scene and complaint numbers are integers from 1 to 100. Each problem number must appear in this section. The maximum number of problems is 99. For multiple-failure problems (not recommended; see discussion in the General Description Section), the failed scene number must be a replaceable scene. A "key" scene, replacement of which will effectively "solve the problem," should be selected.

Example:

```
1:  2 1
2:  11 2
3:  20 3
====
12:  5 11; 12 problems
/
```

11. Section 11 lists, for each problem, those initial switch positions that are to be different from the default settings specified in Section 4. Each problem number is followed by a colon, a switch number, and its initial setting. Succeeding lines cover the initial settings for any other switches for that problem. The appearance at the beginning

of a line of the next sequential problem number followed by a colon terminates the list of initial settings for that problem. The list of initial settings for the last problem is terminated by the slash that ends the section. The switch number and initial setting number on each line are separated by one or more blanks. Each problem number must appear in this section, even if there are to be no initial switch settings that differ from the default setting for that problem. In a case where there are no initial switch settings for a problem, a "0 0" (zero, blank, zero) should be the problem specification.

Example:

```
  1:   0 0
  2:   0 0
  ====
 12:   0 0
  /
```

12. Section 12 lists the conditions used to define which image is to be shown. Conditions are combinations of switch numbers and switch setting numbers that are used to either partially or completely define a state of the simulated equipment. Condition numbers must start with 1 and appear in ascending sequential order with no omissions. A condition may represent a very complex operating mode or something as simple as the setting of one switch.

The first line for a condition contains the condition number, a colon, and the first switch and its setting(s). Each subsequent line contains a switch number followed by one or more setting numbers. If a line contains more than one setting for a switch, that switch may be set to any one of the settings listed. The end of a condition is defined by the first line of the next condition.

Example:

```
  1:   9 2; AC power off
       10 2; standby switch in standby
  2:   9 2;
       10 1; standby switch in operate
  3:   9 1; AC power on
       10 2; standby light on
  ====
834:   7 1; SAT-LOS switch in SAT
       15 2; Dummy load disconnected
       22 1; 28V DC on
       23 1; 440 VAC on
       25 1; Circuit breaker #2 in
       26 1; Antenna power control on
       27 2 3; Antenna #2 selected
       31 1 2; Ships heading N or W
       /
```

13. Section 13 contains the replacement condition number, plus the prerequisite condition numbers for each scene. The replacement condition number is a condition that must be true in order to replace an element or component of the system, often the deenergized state of the system. The replacement condition number is the first item in this section and has an identification number of zero. For example, "0: 0" specifies "any

condition" as the replacement condition. Each subsequent line of this section contains a scene number, a colon, and the prerequisite condition number for viewing that scene.

Example:

```
  0:   0; Replacement condition
  1:   0
  2:   0; as indicated, most of the time there will not
  3:   0; be a prerequisite condition.
  ====
 83:   0
  /
```

14. Section 14 contains the information needed to determine which picture to show for each scene. The data for each scene, image (picture) numbers and condition numbers, are divided into normal and abnormal blocks.

The images for operational modes and scenes in which the indications are the same whether or not there is a malfunction (i.e., normal indications) are represented in the normal blocks. Abnormal blocks list only those images that contain abnormal indications. The data in each abnormal block are related to symptoms rather than to problems. Thus, several problems may point to the same abnormal block of picture data, since different malfunctions can cause the same abnormal indications in a particular scene. A sample section is presented in Figure 10.

15. Section 15 lists those scenes for which abnormal data are to be presented for a particular problem. It is used to select the proper block in Section 14. The problem number is followed by a colon, the first scene, and the block number. Subsequent lines list the remaining affected scenes and their appropriate block numbers for that problem. Normal data are presented for scenes not listed.

Example:

```
  1:   6 1
       7 1
      14 1
      15 1
      18 1
      19 1
      21 1
      24 1
      25 1
  2:   6 2
  3:   6 3
  ====
 19:  18 5
       /
```

16. Section 16 contains the information needed to determine which test equipment reading to show for each test point. The description of each test point is divided into blocks in the manner described for Section 14. Within each block, the picture descriptions for the test point are further broken down by test equipment number. The picture descriptions have the same format as described in Section 14. The beginning of the picture description for each piece of test equipment is marked by a pound sign (#) followed by the test equipment number. An example of this section is presented in Figure 11.

```
1.0:*101                (Note that scene 1 is always the top level diagram and must
      1                 be on fiche 1, image 1. Picture 101 may be shown in any
      0                 equipment configuration.)

2.0:*113                (Normal operation data for scene 2. First picture; one condi-
      1                 tion; show if condition 9 true, no mode conditions.)
      9
    *114                (Again, one condition, no mode conditions.)
      1
     10
 = = = =
6.0:*502                (First picture, scene 6, normal operation; 9 conditions listed.
      9                 If condition 41 true, check for a true mode
     41                 condition; otherwise, check next picture.)
    114
    115
     60
 = = = =
    *419                (Default picture for scene 6. Exhausts all possible alter-
      1                 natives. Note that a "0" could be used as the condition,
     57                 since all possibilities are exhausted.)

6.1:*514                (First abnormal block for scene 6. These pictures include
      2                 malfunction indications.)
     40
      4
    *515
      2
     41
      4
 = = = =
6.2:*514                (This block describes a second class of malfunctions that
      2                 affect this scene.)
     40
    515
      2 4
 = = = =
83.0:*1743
      1
      0
```

Figure 10. Sample picture list.

```
1.0:#1 ;TP-1, Oscilloscope (Normal data for oscilloscope readings.)
     *1005
        9                (To show picture 1005, up to 9 conditions must be
      652                evaluated. If the sufficiencv condition, 652, is true, check
      653                for a true mode condition among conditions 653 and 666. If
      654                652 is false, however, skip to the next picture.)
      655
      656
      661
      663
      665
      666
     *1004
        1
        4
     *1016
        1
        0                (Default condition, show 1016 if not 1005 or 1004.)
     #2 ; Multimeter-Ohms (Readings under same conditions.)
     *1023
        9
      652
      653
      654
      655
      656
  = = = =

1.1:#1                   (Block 1 describes test equipment readings to be pre-
     *1004               sented when the oscilloscope is connected to TP-1, and
        1                the problem is as described in Section 17.)
        0
       #2
     *1028
        1
        0
  = = = =

245.0: #4; 1A2 J5, Frequency Counter
     *1711
        1                (Total of 245 test points; only the frequency counter
        4                may be used at TP-245. No abnormal data.)
     *1703
        1
        0
```

Figure 11. Sample test equipment picture list.

17. Section 17 lists those test points, by problem number, that are affected by the malfunction and the block number that describes the pictures containing the abnormal indications for those test points. It is the last section of data and is used to select the proper block of data in Section 16. The beginning of the list for each problem is marked by the problem number followed by a colon. The rest of that line and subsequent lines for the problem contain a test point number and an associated block number.

Example:

```
1:    1 1    (For problem 1, test equipment readings at TPs 1 to 13,
      2 1    15, and 28 will present abnormal indications that are
      3 1    identified in block 1 for each TP, Section 16.)
      4 1
      5 1
      6 1
      7 1
      8 1
      9 1
     10 1
     11 1
     12 1
     13 1
     15 1
     28 1
2:  231 1
====
/
```

The slash that marks the end of this section also marks the end of the data base.

DATA BASE ENTRY AND CHECKOUT

The total training system includes the hardware, the operating software, the image data base, and the diskettes containing the alphanumeric data base and student data files. Preparing the computer for training use requires the creation of data base text files. The data base text files are then processed to convert them to a data file for running the trainer simulator. A preprocessor checks the data for conformance within definition of the data base. After processing the text files, a number of utility programs are used to check out the data base itself and enter touch point data.

Three diskettes are essential to data base development, checkout, and use. These diskettes, labelled UTILITY, DATA, and TRAINER, each contain appropriate files for particular functions. The UTILITY diskette is used for data base development and instructor operations, the DATA diskette stores the data base text files, and the TRAINER diskette operates the trainer. The relationships between the three diskettes are further outlined in the following pages.

The alphanumeric data base is developed using the text editor function of the computer. The data base preparer creates the data base in two text files labelled RTDATA1.TEXT and RTDATA2.TEXT. Sections 1-13 of the data base are put into RTDATA1.TEXT; and sections 14-17, into RTDATA2.TEXT.

Creating the Text Files

The following steps are essential to creating the data base:

1. Turn computer power on.

2. Insert the UTILITY diskette in the main disk drive and close the drive door. This will automatically start the utility program. The CRT will display:

"NOTE: ONLY THE INSTRUCTOR SHOULD USE THESE FEATURES. USING THE KEYBOARD, ENTER THE NUMBER OF THE DESIRED FEATURE>

1. INITIALIZE DISKETTES FOR NEW STUDENTS.
2. SET PROBLEM SEQUENCE.
3. VIEW THE PRESENT PROBLEM SEQUENCE.
4. OUTPUT STUDENT PERFORMANCE DATA.
5. COPY STUDENT DATA FILES ONTO MASTER COPY DISKETTE.
6. STOP--EXIT THE INSTRUCTOR UTILITIES MODULE. "

3. To create the data base text files, type 6 to exit the instructor module. This takes you to the command level of the computer, where you can use the filer and text editor functions.

4. Type F to enter the system filer, which controls access to files.

5. When in the filer, type D and update the current date. (Though not essential, this step helps you keep track of your progress.)

6. Insert the DATA diskette in the auxiliary drive and close the drive door. This diskette contains "empty" files labelled RTDATA1.TEXT and RTDATA2.TEXT.

7. Type G to get the text file RTDATA1.TEXT. In response to "GET WHAT FILE?," type #5:RTDATA1.TEXT.

The main drive is volume #4 in computer parlance, and the auxiliary drive is #5. The references to "volumes" as #4 or #5 during file operations and editing are always correct. An alternative is to reference the name of the diskette that is in the drive. In this instance, you could use DATA:RTDATA1.TEXT to reference this file.

8. Type Q to exit the filer.

9. Type E to access the editor. The computer will indicate it is creating a backup file for RTDATA1.TEXT.

10. Type I to begin to insert the data base. As you complete each line of the data base, hit the RETURN key.

Lower case letters are obtained by pressing the "DC2" key, which is located on the right-hand keypad. Several editing functions may be needed during data entry. For example, while on a line, you can backspace to correct typing errors but, after completing the line, you must use the D(elete or X(chng functions of the editor, positioning the cursor where you need to make the correction. A list of the available functions is provided at the top of the CRT. Each editor function is concluded by pressing the ETX key.

11. After a portion of the data base has been inserted, you may wish to transfer the material from the workfile in which the inserts are being made to the text file to prevent loss. Type ETX to accept the input.

12. Type Q for quit and U for update. This will write the data base onto the disk.

13. To continue development of the data base, type E to reenter the editor.

14. To reach the point where you left off, you must move the cursor to the end of the text file. The cursor is controlled by the four arrows to the right of the typewriter keyboard and by the "P" key, in conjunction with the "<" and ">" keys, which lets you move forward (>) or back (<) a page at a time, as opposed to moving a line or a character at a time. The J(ump command will let you jump to the E(nd or B(eginning of the file directly.

15. To conclude the editing session, quit and update. If you are using the L2 Editor, the file is automatically saved. If you are using the L1 Editor, you must select F(ile and then S(ave the file. Open the disc drive doors and remove the diskettes. Then turn off the computer. To resume at the next session, merely repeat the first nine steps above, requesting either RTDATA1.TEXT or RTDATA2.TEXT in step 7, depending on where you are in text file development.

As noted in an earlier chapter, the data in some sections need not be complete in order to check out the data base content for normal operation. However, there must be some information in them before the files can be processed for trainer use. Dummy data must be entered in Sections 2 (Replaceable Scene Names), 3 (Initial Complaints), 6 (Replaceable Scene List), 10 (Failed Scene and Complaint Number for Problems), 11 (Initial Switch Settings per Problem), 15 (Abnormal Scenes and Blocks per Problem), and 17 (Abnormal Test Points and Blocks per Problem). The abnormal blocks in Sections 14 and 16 are not needed. Examples of dummy data would be, "1:Replaceable scene," "1:Complaint," "1:1," etc.

Additions and Revisions

Additions and/or revisions to the data base are made as indicated in the paragraphs above. However, you may encounter problems when the data base files RTDATA1.TEXT and RTDATA2.TEXT begin to get large. The message "ERROR: NOT ENOUGH ROOM FOR BACKUP!" may appear when you type E to edit the file. When this happens, you must "crunch" the diskette to remove intervening space. To crunch the diskette:

1. Return to the system filer and type K for "K(runch)."

2. In response to "CRUNCH WHAT VOL?," type DATA or #5.

3. Then type Y in response to "ARE YOU SURE YOU WANT TO CRUNCH DATA?"

4. The filer will then move the data files so that all of the unused space is grouped together at the end of the diskette.

When either of the files RTDATA1.TEXT or RTDATA2.TEXT gets large, crunching the diskette may still not provide enough room for the backup file because of an existing

backup for the other file. In this case, remove the other backup file and then crunch the diskette. The following steps accomplish this:

1. After returning to the system filer, type R for "remove."

2. In response to "REMOVE WHAT FILE?," type DATA:RTDATA1.BACK, or DATA:RTDATA2.BACK, depending on which you need to remove.

WARNING: Be sure to use BACK, not TEXT, as this step completely removes the file you designate.

3. Now, K(runch the diskette.

Backup

Each time you enter the edit function to make changes to the data base, the system automatically creates a backup file containing the current text, labelled RTDATA1.BACK or RTDATA2.BACK. This provides a useful fallback position in case your file somehow gets damaged during editing, provided you are willing to fall back to the condition before editing started. If the text file you're working on gets damaged, you can change the backup file so it becomes your main text file by going back to the filer and typing C (for change). For example, the computer will let you change the label on the backup file from RTDATA1.BACK to RTDATA1.TEXT.

If you elect to change the backup file to replace the text file, in response to "CHANGE WHAT FILE?," type RTDATA1.BACK or RTDATA2.BACK. In response to "CHANGE TO WHAT?," type RTDATA1.TEXT or RTDAT2A.BACK. The computer will say, for example, "RTDATA1.TEXT exists. Destroy it (Y/N)?" Type Y and you will be back to where you started at the beginning of the current editing session.

For further safety purposes, the data base files RTDATA1.TEXT and RTDATA2.TEXT should be copied onto a backup data diskette from time to time to prevent loss. To do this, proceed as follows:

1. At the command level, with the DATA diskette still in the auxiliary disk drive, type F to enter the filer.

2. Remove the utility diskette and insert the diskette you're going to use for backup into the main disk drive. (If the backup diskette is a new diskette, it must be zeroed as outlined in the chapter on data management.)

3. Type T for transfer.

4. In response to "TRANSFER WHAT FILE?," type #5:RTDATA1.TEXT.

5. In response to "TO WHERE?," type #4:$. (The "$" sign equals a "same as" indication to the computer.)

6. If you have previously made a backup on that diskette, in response to "(#4):RTDATA1.TEXT EXISTS. . . REMOVE IT?," type Y.

7. The filer will respond with "DATA:RTDATA1.TEXT TRANSFERRED TO #4:RTDATA1.TEXT" when the transfer is complete.

8. Repeat steps 3-7 for RTDATA2.TEXT.

9. Remove the backup diskette and replace the utility diskette.

10. Type Q to leave the filer.

Printouts

The PRINTOUT.CODE or EPRINT.CODE file on the UTILITY diskette is there to provide for printing out text files. To use the printer, you must first connect it to the computer. Remove the interface cable to the microfiche projector (GMTS) and connect the printer in its place. Then, type X (for execute) and proceed according to which file you want printed:

1. In response to "EXECUTE WHAT FILE?," type PRINTOUT or EPRINT.

2. In response to "PRINT WHAT FILE?," type #5:RTDATA1.TEXT or #5:RTDATA2.TEXT.

3. In response to the list of default settings and the question, "THESE SETTINGS OKAY?," type Y, unless you want to change them (e.g., to add page numbers).

4. The printer will then print out your file and ask, "IS THERE MORE?" Type Y or N, depending on whether you want to print out another file.

Data Base Processing

To preprocess the data base once all sections contain at least some data, proceed as follows:

1. Turn computer power on.

2. Insert the UTILITY diskette in the lower disk drive and the DATA diskette in the upper disk drive and close the doors.

3. Type 6 to exit the utility program.

4. If you want to change the date or crunch the diskette (the diskette must be crunched before processing), type F to enter the filer. If not, type X for execute.

5. In response to "EXECUTE WHAT FILE?," type PREPROCESS.

6. The program will display "DATA BASE PREPROCESSOR."

7. The preprocessor marks its progress through the data base by displaying on the CRT screen the number of each new section of data as it is encountered. When the preprocessor is processing conditions, it displays every one hundredth condition number, as it is processed, on the CRT screen.

8. As the preprocessor encounters errors in the data base, it writes an error message on the CRT and onto the disk file ERRORS.TEXT on the DATA diskette. (See Appendix B. Preprocessor Messages.)

9. When the preprocessor is finished, it displays the message, "DATA PREPROCESSOR PROGRAM FINISHED.," followed by either "THE INPUT DATA FILE CONTAINED ERRORS." or "NO ERRORS WERE DETECTED ON THE INPUT DATA FILE.," depending on whether any errors were encountered.

10. If errors were detected by the preprocessor, the file ERRORS.TEXT on the DATA diskette will contain a list of the errors and can be read or printed out. (See above regarding getting a printout.) Correct the errors, then repeat steps 3-10.

11. When the preprocessor has finished without finding any errors, the file RTDATA.DATA on the DATA diskette will contain the processed data. The RTDATA.DATA file can be checked out using the DATACK program (see below).

Checking Out the Data Base

The DATACK program is used as a preliminary checkout of the data base created initially in RTDATA1.TEXT and RTDATA2.TEXT. It receives input from the keyboard and outputs information to the user on the CRT screen. Microfiche pictures and Graf-pen strikes are not used by DATACK.

To run the DATACK program, perform the following steps:

1. Turn computer power on.

2. Place the UTILITY diskette in the lower disk drive and close the door.

3. Type 6 to exit the utility program.

4. Type X (for execute).

5. In response to "EXECUTE WHAT FILE?," type DATACK. This will start the DATACK program.

6. The CRT will display:

"DATA BASE CHECKOUT PROGRAM
ENTER PROBLEM NUMBER:"

7. Enter a problem number (remembering that normal operation is "0") followed by RETURN.

(CAUTION: Whenever any character other than a number is entered when a number is expected, the program will terminate with an error message.)

8. The CRT will display:

"CURRENT PICTURE = 101
CURRENT CONDITION = 0
CURRENT SCENE = 1
CURRENT TEST EQUIP = 0
CURRENT TEST POINT = 0

ENTER KEY TO SELECT ACTION:

A = NEW SCENE
B = NEW TEST EQUIPMENT
C = NEW TEST POINT

D = CHANGE SWITCH POSITION
E = NEW PROBLEM
F = EXIT PROGRAM
G = SHOW SWITCH SETTINGS"[1]

9. Type the appropriate key, A to G (if G is not shown, typing S will cause the current switch settings to be displayed). The different key strikes will be handled as follows:

a. The CRT will display "ENTER SCENE NUMBER:." Enter the desired scene number, followed by RETURN. This is analogous to pointing to the access point for the scene in the trainer. The CRT display will be updated with new picture, condition, and scene numbers. The scene number will be the scene number just entered. The picture number will be the picture (fiche and image) appropriate to the current switch settings. It is the image that will show when the scene is selected during training.

b. The CRT will display: "ENTER TEST EQUIPMENT NUMBER:." Enter the desired test equipment number followed by RETURN. This is analogous to selecting a piece of test equipment for use in the trainer. The CRT will display the selected test equipment number.

c. The CRT will display: "ENTER TEST POINT NUMBER:." Enter the desired test point number followed by RETURN. This is analogous to connecting the selected piece of test equipment to the test point. The CRT display will be updated with the picture number corresponding to the test equipment reading, the condition number, and the test point number.

d. The CRT will display "ENTER SWITCH NUMBER (=0 TO SELECT NEW MODE):" below the display of the current picture, condition, scene, test equipment, and test point. Enter the number of the switch to be changed. The CRT will then display "ENTER POSITION NUMBER:." Enter the number of the position to which the switch is to be changed. This is analogous to pointing to a switch position in the trainer. If the switch is not on the current scene, it is also equivalent to having pointed to the access point for the current scene or current test point. The current picture number and condition number on the CRT will be updated, and "ENTER SWITCH NUMBER (=0 TO SELECT NEW MODE):" will be redisplayed. You can continue to change switch positions and observe the effect in the current scene until you enter a zero in response to "ENTER SWITCH NUMBER."

e. The current problem will be terminated and the CRT will display "ENTER PROBLEM NUMBER:." Enter a new problem number (see step 8).

f. The program will terminate. The computer will return to the command level.

---

[1]Only the first condition listed immediately after the picture number will be shown. You must press S to see switch settings.

g. The CRT will display all of the switches (by number) and their current settings (by number). An example of this display follows:

"DEPRESS ANY KEY TO CONTINUE
THE CURRENT SETTINGS ARE:

SWT	SET
1	2
2	1
3	1
4	1
5	2
6	3
7	1
8	1
9	2
10	2
11	1
12	3"

Pressing any key will return you to step 8.

Three data base errors encountered by DATACK are considered fatal and will cause the program to terminate. The program will return to the command level of the system after displaying a message indicating the type of error plus the list of the switches and their current settings. The fatal errors are:

1. None of the conditions was true for the current scene.

2. None of the conditions was true for the current test equipment and test point.

3. A switch number in a condition is zero.

Errors in the data base other than fatal errors must be identified by examination and corrected by revision to the data base itself. There is no way to do this automatically. An alternative to using DATACK is to check out the data base visually after the microfiche have been prepared and proofed and the XY data entered.

Definition of Points on Scenes

Touch points on images are defined in terms of X and Y coordinates, with the X and Y positions related to the face of the trainer on the GMTS or to the touch screen bezels on the EEMT. Once the photographic images are available, an XY.CODE program is used to develop and store the touch point data for each scene. The program can be used to create a new XY data base or to make changes in existing ones. The program creates or modifies an RTXYDATA.DATA file on the UTILITY diskette that must then be transferred to the TRAINER diskette.

To run the XY program, perform the following steps:

1. After inserting the microfiche in the GMTS or the videodisc in the EEMT, turn computer power on.

2. Place the UTILITY diskette in the lower disk drive and close the door.

3. Type 6 to exit the utility program and F to enter the filer if it is necessary to update the current data.

4. Type Q to exit the filer and X for execute.

5. In response to "EXECUTE WHAT FILE?," type XY. The CRT displays:

"TOUCH HERE - - > *."

6. Touch the asterisk carefully. This point is used to calibrate all of the touch points used on the CRT during the rest of the program. The CRT now displays:

"CREATE NEW XY DATA FILE *
EDIT EXISTING XY DATA FILE *."

In order to edit an existing XY data file, the UTILITY diskette must contain the current XY data file RTXYDATA.DATA. If you point to "EDIT EXISTING XY DATA FILE" when there is not an RTXYDATA.DATA file on the diskette, the program will terminate abnormally with the message "I0 ERROR: FILE NOT FOUND." After touching "EDIT EXISTING XY DATA FILE," the program will read the data from the file, scroll some of it on the CRT, and then proceed.

7. After touching "CREATE NEW XY DATA FILE," the CRT will display:

"READY TO ACCEPT XY INPUTS

DEPRESS PEN TO CONTINUE."

Touch the pen anywhere.

8. The CRT will now present the main display for the XY program, which has the following format:

"0 1 2 3 4 5 6 7 8 9 ENTER BS ESC YES NO
* * * * * * * * * * * * * * *

DEFINE NEW SCENE *

VERIFY SCENE *

REMOVE SCENE *

SAVE DATA *

EXIT EDIT *

Note. Whenever one of the modes "DEFINE NEW SCENE," "VERIFY SCENE," or "REMOVE SCENE" has been touched by mistake, the mode can be exited by touching ESC before entering the scene number. Once the scene number has been entered, ESC will not exit the mode.

9. To define the XY points for a scene, touch the asterisk next to "DEFINE NEW SCENE." The prompt, "SCENE #," will be displayed. Touch the asterisk below the first

digit of the scene number, followed by the second digit, if any, then touch the asterisk below "ENTER."

The selected digits will be displayed as you touch them. If you touch the wrong digit, you can correct it (before touching ENTER) by backspacing (touch BS), and then touching the correct digit.

10. The CRT will now display "FICHE #." Point to the digits for the fiche number that contains a picture of the scene and then touch ENTER.

11. When the CRT displays "IMAGE #," point to the digits that define the image number on the selected fiche, then touch "ENTER." The image will then be displayed.

Note that any one image of the scene may be used. The XY data entered for the one image will be used for all images of that scene. This minimizes both the task of developing the data base and the storage and computing requirements in the computer. It does require precise registration during photography, as noted in the Operating Procedures section.

12. Touch "YES" or "NO" in response to "CORRECT PICTURE?." If the wrong picture is showing on the microfiche, touch NO and enter the correct fiche and image number as described above. After touching "YES" in response to "CORRECT PICTURE?," the CRT will display:

```
"0  1  2  3  4  5  6  7  8  9      ENTER  BS  ESC  YES  NO
 *  *  *  *  *  *  *  *  *  *        *     *    *    *    *

FICHE# XX

IMAGE# YY

     REFERENCE POINT          *

              SWITCH          *

          TEST POINT          *

           SUB-SCENE          *

DONE WITH THIS SCENE          *
```

where XX and YY are the fiche and image numbers just entered.

(Device 11B106 works substantially the same, except that it shows or demands frame numbers instead of fiche numbers. It also does not require reference points.)

13. Now touch the asterisk next to "REFERENCE POINT." The CRT will display "TOUCH REFERENCE POINT." Carefully touch the reference dot on the microfiche image. The CRT will display "REFERENCE POINT RECORDED - CONTINUE." Touch any where on the CRT.

In the "DEFINE NEW SCENE" mode, if one of the types of points "REFERENCE POINT," "SWITCH," "TEST POINT," or "SUB-SCENE" is touched mistakenly, touching ESC before entering the number will allow you to choose another type without recording anything. However, once the number has been entered, touching ESC will record the point for ESC in the XY data as the type of point you defined. The ESC should only be touched when the program is waiting for a number to be entered, which is evidenced by the number sign (#) next to the mode or point type touched.

14. To define the positions of a switch, touch the asterisk next to "SWITCH" and then define the switch number by touching the appropriate digits followed by "ENTER." Then carefully touch each of the positions on the switch corresponding to the position number displayed on the CRT. Again, it is important to be consistent. If you touch the outer edge of a switch marking to define a point, touch the outer edge to define them all on all switches having similar markings. When all of the switch positions have been touched, touch anywhere on the CRT.

15. To define a test point, touch the asterisk next to "TEST POINT," and then define the test point number by touching the appropriate digits followed by "ENTER." The CRT will display "TOUCH TEST POINT XX." Carefully touch the test point on the microfiche image being shown. Then touch anywhere on the CRT.

16. To define a subscene access point, touch the asterisk next to "SUB-SCENE." Then define the subscene number by touching the appropriate digits followed by "ENTER." The CRT will display "TOUCH SUB-SCENE XX." Carefully touch the subscene access point on the microfiche image being shown. Then touch anywhere on the CRT.

17. When all of the points on the current scene have been defined, touch the asterisk next to "DONE WITH THIS SCENE." The CRT will display "xx POINTS DEFINED," followed by "DEPRESS PEN TO CONTINUE.," where xx is the number of points you have just defined for the current scene. Verify that this number of points is correct and then depress the pen.

Verifying Existing XY Points

To verify the XY points on a scene that has already been defined, point to the asterisk next to "VERIFY SCENE." The CRT will display "SCENE #."

1. Touch the appropriate digits, followed by "ENTER." The picture of that scene will be shown on the microfiche and the CRT will display:

"FICHE# XX

IMAGE# YY

TOUCH REFERENCE POINT."

2. Touch the reference dot on the picture. The CRT will add the following to the display:

"TOUCH HERE * TO EXIT VERIFY ROUTINE."

When you are ready to exit the verify routine, you will touch there.

3. Now touch each of the points on the picture that should be defined. As each point is touched, the CRT will display "SWITCH n POSITION n" if the point was defined as a switch position; "TEST POINT n" if the point was defined as a test point; "SUB-SCENE n" if the point provides access to a subscene; or "UNDEFINED POINT" if the program cannot match the point.

4. After all of the points on the scene have been touched and verified, touch anywhere on the CRT to exit the VERIFY mode.

Editing Existing XY Data

To edit the XY data, you must first remove the XY data for the scene. Touch the asterisk next to "REMOVE SCENE DATA." The CRT will display "SCENE #." Touch the appropriate digits, followed by "ENTER." A picture of the scene will be shown on the image display screen and the XY data for the scene will be removed from the data base. A shortcut way, if you are editing, is to touch "DEFINE NEW SCENE." In either case, the CRT will now display:

"FICHE# XX

IMAGE# YY

SCENE xx DATA REMOVED

DEPRESS PEN TO CONTINUE."

Depress the pen, then define your new data as above.

Saving XY Data

XY data is not input to the data file until it is saved. To save newly defined or modified data, touch the asterisk next to "SAVE DATA." The CRT will display:

"THIS WILL UPDATE EXISTING XY DATA FILE - OK?"

Touch "YES" or "NO." If you touch "YES," the data file will be saved on the upper diskette and the CRT will display:

"XY DATA FILE SAVED.

DEPRESS PEN TO CONTINUE."

Touch anywhere with the pen.

Exiting the XY Program

When the XY data file has been created, modifications have been made, and the data file has been saved on disk, touch "EXIT EDIT" to terminate the program and return to the

command level of the system. If any data has been changed but not saved, when "EXIT EDIT" is touched, the CRT will display:

"LATEST CHANGES NOT SAVED - DO YOU WANT TO SAVE?"

Touch "YES" or "NO." If you touch "YES," the data will be saved in the same way as touching "SAVE DATA." If you touch "NO," the program will terminate without saving the data and the latest changes will be lost.

Preparing the TRAINER Diskette

Prior to running the trainer, new or revised RTDATA.DATA and RTXYDATA.DATA files must be transferred to the TRAINER diskette. At the command level, with the TRAINER diskette in the auxiliary drive and the UTILITY diskette in the main drive, proceed as follows:

1. Type F to enter the files.

2. Type T for transfer.

3. In response to "TRANSFER WHAT FILE?," type #4:RTDATA.DATA (or #4:RTXYDATA.DATA).

4. In response to "TO WHERE?," type #5:$.

5. If you're replacing an existing file, in response to, for example, TRAINER: RTDATA.DATA EXISTS. . . REMOVE IT?," type Y.

6. Type Q to leave the filer.

PHOTOGRAPHY

Pictures of equipments and portions of equipments that serve as pathways to scenes, scenes that define all the states to be simulated, and test equipments or test equipment readings are required for the simulation. Top level and intermediate level images are often produced via a combination of photographs and graphic art (see Figures 1, 2, and 12 for examples). Scenes are photographed from the real equipment, using the picture list as a guide.

Normally, a system consists of several major equipments, a number of peripheral units, and possibly some special test equipment such as dummy loads or signal generators. The top level image must either contain all of these or elements or subsections that contain the major units (e.g., see Figure 12). An effective technique for assembling the top level image is to cut out photographs of each unit and arrange them on a diagrammatic background, as in Figure 2. A second approach is to produce a line drawing showing each unit, omitting most of the detail, as in Figure 12. In either case, each element in the figure should be labelled by name. A symbol large enough to be readily apparent that will be used to select each unit for viewing must be provided. The same symbol should be used throughout the drawings and photographs to indicate that the student may obtain a closer view of some equipment element by touching the symbol.

Images that are to be placed on microfiche must include a reference point, which is used to calibrate the touch points on the image. Reference points (dots) and other

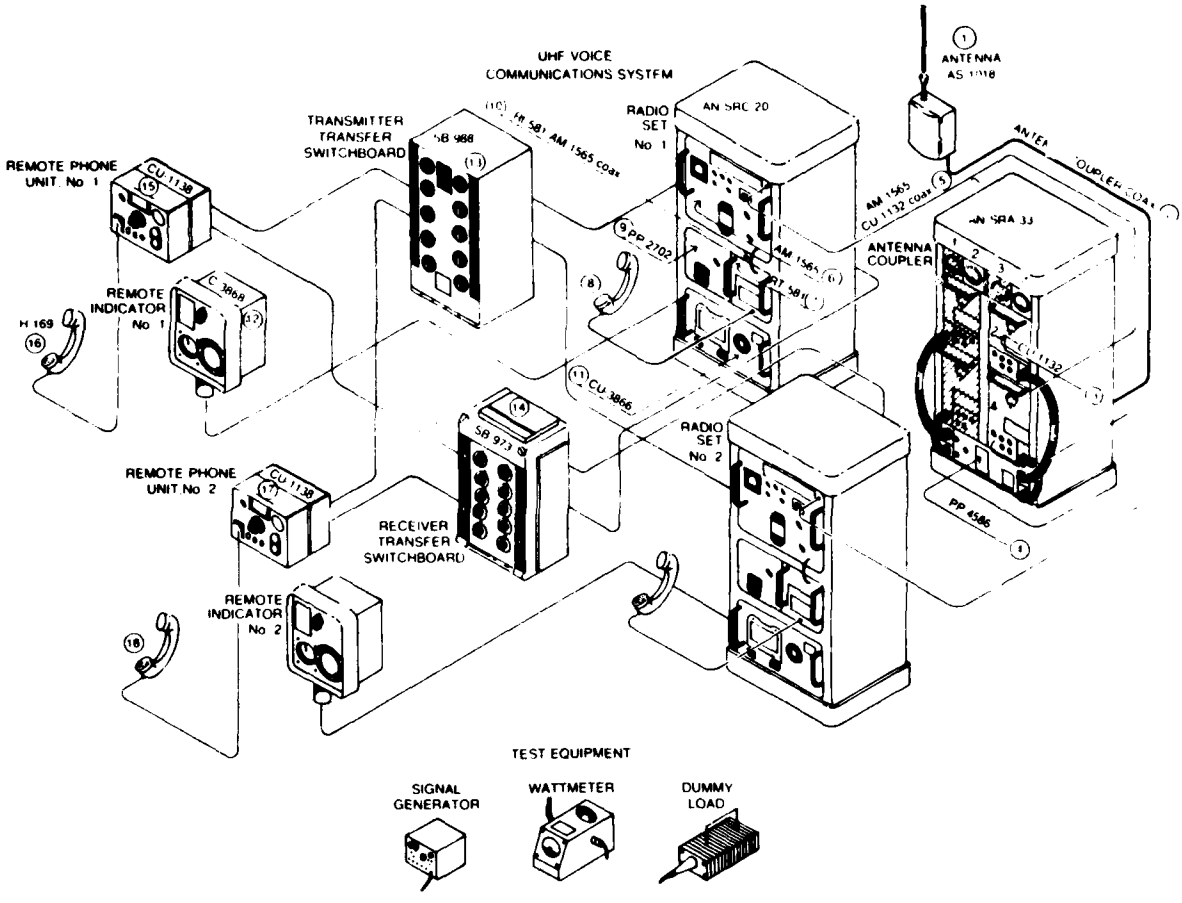

Figure 12. UHF comunications system top level view.

markings must usually be affixed on the equipment during photography to assure precise registration in the final photograph. In establishing reference points, scene access points, auxiliary switch markings, etc., it is important to be consistent. Markings placed on the equipment for photography should have consistent meanings throughout the data base and should be of a consistent size in the finished product. Reference points should be in the same positions on all images and must be in the lower right-hand corner of the image.

Access points for equipment should be in essentially the same relative position on all equipment.

It is strongly recommended that an experienced photographer perform the actual lighting and camera setups, and that test shots of various scenes be made for best results, noting the camera and lighting setup employed for each. While this requires a few extra days, it is a good investment of time.

Photographing Scenes

All images can be traced to scene numbers. Technically, however, only those views of the equipment within which switch settings can be altered, indicators read, and test points touched are defined as "scenes." The discussion that follows applies to this kind of scene.

Scenes usually require a number of images representing different states. The steps involved in producing scene images require mounting the camera on a solid tripod, using a shutter release cable, and positioning the camera so that the scene fills the viewfinder as much as possible. Indicators, controls, or test points that are not part of that scene should not appear in a scene. Scenes shaped such that unwanted portions of the equipment will appear must have the unwanted portions shielded from view by paper or cloth masking. All images for a particular scene should be shot at one "sitting" so that registration of touch points will be identical for each image.

Most switch settings will already be marked on the equipment panel and will require no further marking. However, some switches, such as toggle switches and push buttons, must have touch points and labels affixed so that the student can see how they are set and have a touch point to actuate them. Nonilluminated push buttons are a particular problem in that you can't see whether they are in or out in a head-on shot.

Setup

The preferred photographic setup is to use a 35mm SLR camera with a TV mask in the viewfinder. A short focal length lens that will permit sharp focus on essential features in the scene is also preferred. The use of Ektachrome 50 Tungsten EPY 135-36 ASA40 color film has proven successful in the past. Use of a filmpack for scenes requiring more than 36 images is recommended to retain precise registration. Umbrellas to diffuse the light source and permit even distribution of light are highly recommended. The following procedures are suggested:

1. Set up camera and lights carefully, avoiding shadows, reflections, and glare. In particular, too much illumination is distracting and may cause light covers to reflect, giving the illusion that the lamps are illuminated. Area lighting such as overhead fluorescent lighting should be turned off, since fluorescent lamps tend to impart a green tinge. Care must also be taken to ensure that light reflected from walls does not distort color. It is often advisable to screen off reflective surfaces around the scene by using screens or drapes.

2. Adjust the framing to include a slight border of about 1/16 of the total desired image within the video mask in the view finder.

3. If reflections from metal or glass surfaces are a problem, a matte spray may be effective in softening the effect.

4. Set the controls and indicators in the scene to match the first mode listed in the picture list for that scene. Take the picture, and then advance the film. Repeat for all conditions in the picture list, making sure that camera placement is not changed at any time.

Ideally, the picture list will be followed in sequence. If it is necessary to depart from the sequence listed, either the picture list or the photographs must be renumbered after reproduction.

5. Photographing scenes for abnormal indications may require that a malfunction be physically introduced in the equipment in order to create the desired abnormal state. Often, however, the appearance of abnormal states can be simulated, as in one of the following ways:

a. Remove or loosen an indicator light to make it appear to be "off."

b. Loosen the set screw locking a control to its shaft. In this way, a switch can appear to be in one position when it is actually in another position.

c. Manipulate controls not on the scene to create the desired state.

6. Red indicator lamps are extremely difficult to photograph due to the lack of film sensitivity in the red area of the color spectrum. Ensure that a red lamp in the off position is extremely dark as compared to a red lamp in the on position.

7. Avoid overexposure, since the resulting image will be bleached out. Normally exposed or very slightly underexposed slides are usually acceptable.

Checking the Slides (GMTS)

After receiving the mounted slides back from the photographic processing laboratory, each slide should be checked against the picture list and coded with its fiche and frame number. (Keep in mind that, if any image is missing, an entire series may have to be reshot in order to have consistent registration and color.)

See Developing New Simulations section (p. 15) regarding numbering the microfiche images.

Ordering Microfiche (GMTS)

When ordering microfiche, the orientation of each slide on the microfiche must be noted on the layout form. "H" specifies that the long axis of the slide should be horizontal in respect to the viewer's perspective; and "V", that the long axis should be vertical. Keep in mind, however, that vertical orientation is inconsistent with current techniques for videodisc production. Therefore, use of the vertical orientation must be avoided.

Microfiche layout and order forms can be obtained from Eastman Kodak at the address below:

Eastman Kodak
365 Ridge Road, Bldg. 65
Rochester, New York 14650
ATTN: Ed Klusa (716) 722-0358

When the proof set is received from Eastman Kodak, extreme care should be taken in confirming these fiche for proper image placement. Any errors should be noted and relayed to Kodak for correction.

The number of copies to order will depend upon the intended use; however, 48 is the current minimum number of copies per microfiche master. Upon receiving the complete order, be sure to check again for errors in the completed microfiche.

OPERATING PROCEDURES

Input

The touch-pen (spark-pen or acoustic stylus) is the sole input device for student input to the GMTS. For maximum effectiveness, the stylus should be held in the same position at all times, with the blue stripe up. Upon pressing the CRT, menu, or microfiche display screen, the student should hear a faint click, indicating the spark discharge has occurred. When the touch-pen "ears" hear the spark discharge, the XY coordinates of the strike are computed and the appropriate computer response is initiated.

Instructors may operate the system in student mode, using only the touch-pen for input. In addition, there are special instructor modes that the instructor uses to enter and check out the data base (if that is his role) and manage student data. The instructor uses the touch-pen and a terminal keyboard for input. The instructor modes are described below and in the section on data management.

Start Up

To start up the trainer, proceed as follows:

1. The trainer must be connected to a standard 115/120 VAC, 60 Hz power source.

2. A microfiche cassette containing the images for the desired simulation must be inserted.

3. Trainer switches should be in their normal positions as follows:

CONTROL	LOCATION	REQUIRED SETTING
Graf-pen power switch (yellow)	Electronics bay	ON (lighted)
Graf-pen rate switch	Electronics bay	Pulled out[2]
Graf-pen mode switch	Electronics bay	POINT
Microfiche power switch	Rear control panel	ON
Microfiche computer/manual	Rear control panel	COMPUTER

4. Turn on the main power switch (inside electronics bay) and the computer switch (front of main drive).

5. Insert a student (or instructor) diskette in the auxiliary disk drive and the TRAINER diskette in the main disk drive. Close the doors.

---

[2]If unit has red dot on button, it should be pushed in instead.

6. The system will automatically initialize, presenting information on the CRT. At this point, the CRT will display:

TOUCH CENTER (BETWEEN EARS):

7. Touch the center of the asterisk (*) as accurately as possible. This point will be used to calibrate all of the subsequent strikes on the system; therefore, the accuracy of the touch is quite important.

8. The CRT will now display:

TOUCH HERE - - >*

Again, accuracy is important, as this touch defines points on the CRT.

9. The CRT will now display:

"TOUCH DOT FOR INTERPRET T/E READING ON COMMAND STRIP."

Again, the accuracy of the touch is quite important, because the location of the other dots on the command strip are defined relative to this touch.

10. The program will now read the limiting pool number (highest problem set allowed at this point; see discussion in the chapter on data management). The limiting pool number is the number of the pool from which problems may be drawn. This assures that students do not work problems that deal with malfunctions or methods beyond those covered in class. The CRT will display:

"THE CURRENT LIMITING POOL NUMBER IS <some number>.
DO YOU WISH TO CHANGE THE LIMITING POOL NUMBER?

* YES*

* NO*"

Touch YES or NO depending on whether you wish to change the limiting pool number for this session.

11. If you touched YES, the CRT will display the numbers from 1 to the maximum number of pools. Touch the asterisk next to the limiting pool number desired for the current session.

12. Now verify the numbers by touching YES or NO in response to the display:

"THE NEW LIMITING POOL NUMBER IS <some number>
IS THIS CORRECT?

* YES

* NO"

This step will be repeated until the response is YES.

The trainer is now ready to accept the first student.

13. The trainer reads the student name from the student diskette in the upper disk drive and displays:

"ARE YOU <some student name>?

* YES

* NO"

Touch YES if the name is correct, NO if not.

14. If you touched NO, the CRT will now display:

"INSERT DISKETTE FOR NEW STUDENT.

POINT HERE * WHEN DISKETTE HAS BEEN INSERTED."

Open the door of the upper disk drive and remove the student diskette currently in the drive. Replace it with the correct student diskette, close the door, and touch the asterisk on the CRT. Step 13 will then be repeated.

15. If the name on the student disk was "Instructor," it is necessary to select a problem to work. Otherwise, the problem will be selected automatically for the student. For the instructor, the CRT will display each of the possible problem numbers and the message "PLEASE TOUCH THE * BEFORE THE EXERCISE YOU WOULD LIKE." Touch the asterisk next to the appropriate number.

Running the Trainer Program

The student tells the trainer what he wishes to do by touching the touch-pen to the appropriate place on the CRT, display screen, or command menu. The trainer will change the projected image in response to each recognized strike on the image display screen. Each new image will reflect the current settings of system switches and appropriate indications on any meters, lamps, test equipment, etc., that are affected by the switch settings and the current malfunction. Whenever a touch-pen input cannot be recognized by the trainer or whenever the trainer needs to draw the student's attention to the CRT, it produces an audible "beep." (GMTS only; the EEMT does not have this feature.) For some errors, a message appears on the CRT to tell the student what his error was or what he is to do. For example, if the computer cannot identify the strike, the CRT will say, "STRIKE NOT RECOGNIZED. PLEASE TRY AGAIN." Sample messages are listed in Appendix C.

When the trainer selects a problem for the student, it displays the complaint associated with the problem on the CRT. If the problem is a test problem, the test mode will also be indicated at this time. For example:

"TEST MODE

OPERATOR'S COMPLAINT: THE MALFUNCTION LIGHT IS ON."

The top level diagram of the system will be showing on the image display. The student may now begin to troubleshoot the current problem.

To start a problem, the student must touch the reference dot on the image display screen. Also, each time a new image is shown, the user must touch the reference dot on the image before touching anything else on it. He may, however, make menu selections or respond to questions on the CRT without pointing to the reference dot. To go through a problem, the student proceeds as follows:

1. To view an intermediate level image or to reach the scene level, the student must touch the subscene selection symbol on the higher level image that provides access to that section. Each section for which there is a more detailed picture will contain this marker.

2. To change the position of a switch showing on the display screen, the student must touch the desired switch position. A new image reflecting the new switch position and any indications affected by the new switch position will be shown automatically.

3. To connect test equipment to a test point or pin (see para. 4.c. below) and view the test equipment reading, the student must touch the appropriate test point or pin showing on the image display screen.

4. To exercise any of the menu functions, the student must touch the dot associated with the desired menu item. The menu items are listed in Figure 13.

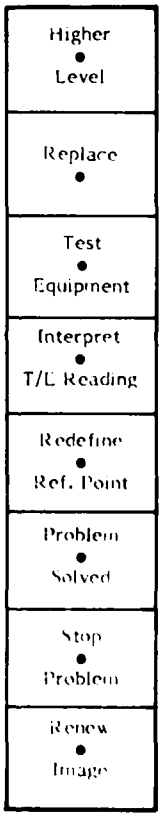

Figure 13. Command menu.

The functions of each of the menu items are outlined below:

a. Higher Level. The HIGHER LEVEL command causes the next higher level image in the image base hierarchy to be displayed. During image selection, the computer progressively stores up to 10 levels in a stack, starting with the top level image. The stack is incrementally downloaded to present the next higher level each time the student presses HIGHER LEVEL.

b. Replace. The REPLACE command indicates that the student wishes to replace the element of the system represented currently on the display screen. The trainer evaluates a replacement condition listed in the data base. If this condition is not satisfied, the trainer "beeps" and displays on the CRT:

"REPLACEMENT IS NOT PERMITTED UNTIL THE SYSTEM
IS PROPERLY DEENERGIZED."

The trainer next checks to see whether the element represented is a replaceable scene. If it is not, the element cannot be replaced, and the program "beeps" and displays on the CRT:

"THE ELEMENT BEING DISPLAYED IS NOT REPLACEABLE."

If the element is a replaceable scene and the replacement and prerequisite conditions are satisfied, the element is "replaced" and a message to that effect is presented:

"THE <element name> HAS BEEN REPLACED."

If the faulted unit has been replaced, the picture data are updated to reflect normal operation. A new image is presented, if there were abnormal indications on the current display.

c. Test Equipment. The TEST EQUIPMENT command lets the student select test equipment with which to make test readings. The CRT displays a list of the test equipment, indicating what test points they are connected to or "-----" if they are not connected to anything. For example:

```
"    TEST EQUIPMENT:        CONNECTED TO:
   * OSCILLOSCOPE            -----
 > * MULTIMETER              1A1A2 J14
     FREQUENCY COUNTER       -----
   ======                    -----          "
```

To select a piece of test equipment, the user points to the asterisk (*) next to the desired test equipment name. A > next to the test equipment name identifies the currently selected test equipment. If that test equipment is currently connected to a test point, the CRT will display "*DISCONNECT" to allow the user to disconnect it, which provides a convenient way to disconnect the equipment if leaving it connected would cause signal distortion or interfere with operation.

The data base preparer must choose between allowing the student to adjust the test equipment prior to getting a test reading or providing a test equipment reading immediately. If the choice is to require adjustment, an image of the selected test equipment will be displayed at this point. The data to permit adjustments must be in the data base. The student will be allowed to adjust the equipment as he sees fit. When he completes the adjustment, he must touch HIGHER LEVEL to connect the equipment to the test point.

After a piece of test equipment has been selected (and adjusted if that is desired), pointing to a test point causes the test equipment to be disconnected from any prior test point and connected to the new test point. Connecting a piece of test equipment to a test point also causes any other test equipment to be disconnected from that particular test point. A picture of the test equipment reading will be shown on the image display screen.

d. Switch Settings. The SWITCH SETTING command lets the student check switch settings in the course of troubleshooting. This facility is essentially a mnemonic device to aid recall during the problem. The list of switch settings is prepared from the names contained in Section 4 of the data base and is presented on the CRT. The order of the listing will be the order in the data base. Brevity and clarity in the assigned names is essential. In order to fit the data on the CRT, a limitation has been placed on the combined length of switch plus position names (38 characters). The list will have essentially the following form:

"SWITCH	SETTING
Local Modulation Sw.	1200PSK
Local Xmtr Key	OFF
Local Handset Key	OFF
=====	====="

e. Interpret T/E Reading. The INTERPRET T/E READING command lets the student question whether a test equipment reading is normal or abnormal. If the test equipment indication is abnormal, the CRT will display:

"THIS READING IS ABNORMAL."

However, if the indication showing is normal, the CRT will display:

"THIS READING IS NORMAL."

The INTERPRET T/E READING function cannot be used during a test problem. If the student does touch INTERPRET T/E READING during a test problem, the trainer will emit a "beep."

f. Redefine Reference Point. The REDEFINE REFERENCE POINT command lets the student redefine the reference point if his touch-pen strikes are not being recognized.

g. Problem Solved. Pointing to PROBLEM SOLVED indicates that the student thinks he has solved the problem by replacing the malfunctioning section of the system.

Since this can terminate a problem, the program first verifies that the user indeed wished to point to PROBLEM SOLVED by displaying:

"DID YOU POINT TO PROBLEM SOLVED ON THE MENU?

* YES

* NO. "

In practice mode, the message, "GOOD, YOU HAVE SOLVED THE PROBLEM." will be displayed and a new problem will be selected, if indeed the malfunction has been replaced. Otherwise, the CRT will display:

"THE PROBLEM HAS NOT BEEN SOLVED.

POINT HERE* TO CONTINUE THE PROBLEM."

In test mode, the program will go on the the next problem.

h. Stop Problem. The STOP PROBLEM command lets the student terminate the current problem to end a session or to choose another problem, if additional problems are available. The program first verifies that the user pressed STOP PROBLEM by displaying:

"DID YOU POINT TO STOP PROBLEM ON MENU?

* YES

* NO. "

If the student points to YES, the student is asked:

"DO YOU WANT TO WORK A NEW PROBLEM?

* YES

* NO. "

If the student points to "YES," the current problem will be marked as "aborted" and a new problem will be presented. If the user points to "NO," the program will terminate, write the student data to disk, and wait for a new student. On restart, the program will restart the current problem.

i. Renew Image. Touching RENEW IMAGE causes the microfiche projector to eject and reselect the currently desired image. This may be necessary if the microfiche projector accidentally brings up an image in the wrong position or unfocused, no image, or two images at a time.

Test Problems

If there are test problems to be completed after the student has completed the last practice problem, the trainer will display:

"YOU HAVE COMPLETED THE PRACTICE PROBLEMS.

DO YOU WISH TO PROCEED WITH THE TEST AT THIS TIME?

* YES

* NO."

If the student points to "YES," the first test problem will be presented to him at that time. If he points to "NO," the current session will be terminated, and the first test problem will be presented at the beginning of his next session.

Shutting Down the Trainer

The trainer must not be shut down during a problem. It should be shut down only after the problem has been successfully completed or terminated and the session stopped; that is, while the computer is waiting for a new student diskette to be inserted, since only in that state will there be no fiche in the projector. When the trainer is in this state, the CRT will display:

"INSERT DISKETTE FOR NEW STUDENT.

POINT HERE * WHEN DISKETTE HAS BEEN INSERTED."

At this point, open the drive doors, remove both diskettes, and then turn the power off.

DATA MANAGEMENT

General

Data management, for the purposes of this manual, includes the process of establishing problem control, creating (initializing) student diskettes, collecting student performance data, and summarizing the data. The processes are described below. During these processes, the Graf-pen and microfiche projector may be turned off, as they are not used.

Zeroing Diskettes

Before they can be used, the directories of new diskettes and student diskettes that are to be reused must be zeroed (removed). To zero directories, perform the following steps:

1. Turn computer power on.

2. Place the UTILITY diskette in the lower disk drive, place a new diskette or a diskette that is to be reused in the upper disk drive, and close the drive doors. This will automatically start the utility program. The CRT will display:

"NOTE: ONLY THE INSTRUCTOR SHOULD USE THESE FEATURES.

USING THE KEYBOARD, ENTER THE NUMBER OF THE DESIRED FEATURE.

1. INITIALIZE DISKETTES FOR NEW STUDENTS.
2. SET PROBLEM SEQUENCE.
3. VIEW THE PRESENT PROBLEM SEQUENCE.
4. OUTPUT THE STUDENT PERFORMANCE DATA.
5. COPY STUDENT DATA FILES ONTO MASTER COPY DISKETTE.
6. STOP - - EXIT THE INSTRUCTOR UTILITIES MODULE."

3. Type 6 to exit the utility program.

4. Type F to enter the filer. If you plan to initialize diskettes after they are zeroed, enter the proper date, by typing D, if you haven't already done so.

5. Type Z to zero the diskette in the upper drive.

6. In response to "ZERO DIR OF WHAT VOL?," type #5.

7. If the diskette has already been used, the CRT will display "DESTROY <volume name>?." The data on the diskette will indeed be destroyed, so type Y only if you are sure you do not need the data.

8. In response to "DUPLICATE DIR?," type N.

9. In response to "# OF BLOCKS?," type 494.

10. In response to "NEW VOL NAME?," type STUDENT, INSTRUCTOR, or MASTER (see below), depending on which diskette you are zeroing.

11. In response to "STUDENT: CORRECT?," "INSTRUCTOR: CORRECT?," or "MASTER:CORRECT?," type Y. The CRT will display "<name>: ZEROED."

12. To zero additional diskettes, open the upper disk drive door, replace the zeroed diskette with the next one to be zeroed, and proceed as above.

Initializing Student Diskettes

Initializing student diskettes is the first of the utility programs. The directory of the student diskette must have been zeroed previously. With the UTILITY diskette in the lower drive, initialize the system as outlined above. The CRT display will be as in step 2 above.

1. Type 1 to select the procedure to initialize diskettes. The CRT will display:

"ENTER STUDENT NUMBER:."

2. Enter the student number (no more than two digits). Enter a zero if the diskette is to be an instructor diskette. If the student number is zero, the student name "Instructor" is automatically generated.

For other student numbers, the CRT will display "ENTER STUDENT NAME:"

3. Enter the student name.

4. In response to, "IS <student name> CORRECT? (Y/N)," type Y or N. If N, enter the correct student name.

5. The CRT will now display:

"INSERT THE DISKETTE FOR <student name>.

PRESS THE SPACE BAR WHEN DISKETTE HAS BEEN ENTERED.

(ESC KEY WILL TERMINATE THIS UTILITY)"

6. Put the student diskette into the upper disk drive, close the door, and press the space bar. The student data files are written onto the diskette in the upper disk drive at this time. The CRT displays:

"DO YOU WISH TO INITIALIZE ANOTHER STUDENT DISKETTE? (Y/N)?"

7. Enter Y if there are more diskettes to be initialized, remove the current student diskette, and repeat the above steps. Enter N when all of the diskettes have been initialized.

As each student diskette is removed from the disk drive, write the student number on the diskette label so that it can be positively identified at all times.

8. After typing N, the main CRT display (step 2 under "zeroing") will be presented. Type 6 to exit the utility program and to return to the command level of the system. Open the drive doors, remove the diskettes, and turn off power to the system.

Establishing Sequence of Problems

There are two types of problem pools: practice pools and test pools. Problem pools consist of a number of problems assigned to particular lesson sessions. The instructor must set up the pools prior to trainer use. During trainer operation, pools are selected in sequence--practice pools followed by test pools. Within pools, the trainer selects problems at random from the unworked problems until the student has completed the required number of problems; for example, four problems required in a pool of six.

The primary differences between practice mode and test mode are the elimination of the "INTERPRET T/E READING" help and termination of the problem in test mode as soon as the student indicates "PROBLEM SOLVED."

To establish the pools of problems, perform the following steps:

1. Turn computer on.

2. Place the TRAINER diskette in the upper disk drive, place the UTILITY diskette in the lower disk drive, and close the doors. The UTILITY program will start automatically.

3. Type 2 to enter the set problem sequence utility. The CRT will then display:

"SET PROBLEM SEQUENCE: YOU MUST DECIDE HOW MANY PRACTICE PROBLEMS AND HOW MANY TEST PROBLEMS MUST BE DONE BY EACH STUDENT AND HOW THE PROBLEMS SHOULD BE SELECTED.

ANSWER THE NEXT TWO QUESTIONS BY TYPING THE NUMBER AND THEN HITTING THE RETURN KEY.

HOW MANY PROBLEMS ARE DEFINED IN THE DATA BASE?

DEPRESSING THE ESC KEY AT ANY TIME WILL EXIT THE SET PROBLEM SEQUENCE FUNCTION WITHOUT SAVING THE NEW PROBLEM SEQUENCE DATA."

4. Type in the total number of problems defined in the data base. The CRT will add to the above display:

"HOW MANY PRACTICE PROBLEMS SHOULD STUDENTS BE REQUIRED TO DO?"

5. Type the total number of practice problems to be required in all lessons. The number of practice problems must be no greater than the number of problems defined in the data base. The number of practice problems may be zero if only test problems are to be presented to the student. The CRT will add to the above display:

"HOW MANY TEST PROBLEMS SHOULD STUDENTS BE REQUIRED TO DO?"

6. Type the total number of test problems to be required. The number of test problems must be no greater than the total number of problems defined in the data base minus the number of practice problems. The number of test problems may be zero if only practice problems are to be presented to the student. The CRT will add to the above display:

"THIS MEANS THAT STUDENTS MUST DO A TOTAL OF xx PROBLEMS

DO YOU WANT TO CHANGE THESE VALUES? IF NOT, TYPE "N"."

7. Type "N" to continue. Type any other key to change the number of problems in the data base or the number of practice and/or test problems, and repeat from step 4. The CRT will then display:

"# OF PRACTICE PROBLEMS REQUIRED = <number>

OF TEST PROBLEMS REQUIRED = <number>

ANSWER THE NEXT TWO QUESTIONS BY TYPING THE NUMBER AND THEN HITTING THE RETURN KEY. THE TOTAL OF PRACTICE AND TEST POOLS MUST BE LESS THAN OR EQUAL TO <sum of the above>

HOW MANY PRACTICE POOLS SHOULD THERE BE?"

8. Enter the number of practice pools. This number must be no greater than the number of practice problems. The only way to set the exact order in which problems are presented to the student is by defining each pool as consisting of only one problem (i.e., specifying the same number of pools as there are problems). The number of practice pools will automatically be set to zero if the number of practice problems is zero. The CRT will add to the above display:

"HOW MANY TEST POOLS SHOULD THERE BE?"

9. Enter the number of pools that are to contain test problems. This number must be no greater than the number of test problems displayed at the top of the CRT. The number of test pools will automatically be set to zero if the number of test problems is zero. The CRT will then add to the above display:

"DO YOU WANT TO CHANGE THESE VAUES?

IF NOT, TYPE 'N'."

10. Type N to continue. Type any other key to change either of the numbers entered above. The CRT will now display:

" # OF PRACTICE PROBLEMS REQUIRED = n # OF PRACTICE POOLS = nn

ENTER PROBLEM NUMBERS (EACH FOLLOWED BY THE RETURN KEY) FOR POOL 1.

(DEPRESS THE ETX KEY AFTER ENTERING THE LAST PROBLEM.)

POOL # PROBLEMS # REQUIRED "
1

Note that a particular problem may appear in only one pool.

11. Enter the problem numbers that are to be in the first pool. The problem numbers appear on the CRT as they are entered. The BACKSPACE key may be used for making corrections before hitting the RETURN key. Hit the RETURN key after every number, even the last one.

Once a problem number has been placed into a pool by hitting the RETURN key, the only way to change the number is to redefine the pool. This may not be done until all practice pools and test pools have been defined, unless you opt to exit the entire SET PROBLEM SEQUENCE function without saving the problems that have been placed in pools. This you can do by depressing the ESC key.

12. After all of the problems have been entered into the first pool, depress the ETX key. The CRT will display:

"ENTER THE REQUIRED NUMBER OF PROBLEMS FOR POOL 1."

13. Enter the number of problems from pool 1 that must be worked by the student. This number must be less than or equal to the number of problems defined for the pool.

14. Repeat steps 12 and 13 for each of the practice pools. After the number of practice problems has been entered for each pool, the computer will check to see if enough problems have been placed into pools to satisfy the number of practice problems required. If there are not enough problems, the message "*** NOT ENOUGH PROBLEMS IN POOLS. ADD TO POOL # ***" will be displayed.

15. Enter the number of the pool to which problems are to be added. The problems in that pool will be displayed. Add problems to the pool, as in step 11. Depress the ETX key when finished adding problems. Then reenter the number of required problems for this pool. The above steps must be repeated until there are at least as many problems in pools as the number of practice problems required.

16. Now the program will check to see if the sum of the problems required for each pool matches the number of practice problems required. If it does not, the message "*** TOO MANY (OR NOT ENOUGH) PROBLEMS REQUIRED. CHANGE FOR POOL # ***" will be displayed. Enter the number of the pool for which the number of required problems is to be changed.

17. The problems in that pool will be displayed. Reenter the number of required problems for that pool.

18. These steps must be repeated until the sum of the problems required for each pool is exactly the number of practice problems required.

19. Now define the pools for test mode in the same manner.

20. At this point, you will be given an opportunity to redefine some of the pools. The message "*** DO YOU WANT TO CHANGE ANY POOLS? TYPE Y OR N. ***" is displayed. Type "Y" to redefine a pool.

21. In response to "*** WHICH POOL WOULD YOU LIKE TO CHANGE? ***," enter the number of the pool followed by the RETURN key.

22. The problems for that pool will be erased from the CRT and the cursor will be placed next to the pool number. Redefine the pool as in steps 11 to 13.

23. Repeat the above steps until the response to "DO YOU WANT TO CHANGE ANY POOLS?" is "N."

24. At this point, the data will be written into the file SEQ on the diskette in the upper disk drive.

25. The "Set problem sequence" utility will be terminated and the CRT will display the main display for the utility program.

26. Enter "6" to exit the utility program and return to the command level of the system.

Examining the Problem Sequence

To view the currently defined pools, the problems they contain, and the number of problems required, perform the following steps:

1. Turn computer power on.

2. Place the TRAINER diskette in the upper disk drive, place the UTILITY diskette in the lower disk drive, and close the doors. The utility program will start automatically.

3. Type 3 to view the present problem sequence. The current problem sequence data will be read from disk. If no problem sequence data exists on the TRAINER diskette, the CRT will display:

"NO PROBLEM SEQUENCE DATA EXISTS.

DEPRESS ANY KEY TO CONTINUE."

Otherwise, the CRT will display the problem sequence data read from the disk in the following format (numbers inserted for illustration only):

"PRACTICE MODE:
OF PRACTIVE PROBLEMS REQUIRED = 11
OF PRACTICE POOLS = 7
(DEPRESS ANY KEY AFTER VIEWING THESE POOLS.)

POOL #	PROBLEMS	# REQUIRED
1	1 4 5	2
2	2 3	2
3	6 8 9	1
4	7 10	1
5	11	1
6	12 13 14	3
7	15	1"

5. Depress any key to see the test pools, which will be displayed similarly.

6. Depress any key to return to the main display of the utility program.

7. Depress "6" to exit the utility program.

Printing Student Performance Data

To print out student performance data, perform the following steps:

1. Disconnect the microfiche projector from the computer (RS-232 interface on the main disk drive).

2. Plug in the printer.

3. Turn computer power and printer power on.

4. Place the UTILITY diskette in the lower disk drive and close the door. This initializes the system.

5. Type 4 to output student performance data.

6. The CRT will display:

"UTILITY FOR PRINTING STUDENT DATA FILE SUMMARIES

ENTER TODAY'S DATE:

MONTH (1. . .12):"

7. Enter the number of the current month. Then, in response to "DAY (1. .31):," enter the day, and in response to "YEAR: 19," enter the last two digits of the year. The CRT will then display:

"UTILITY FOR PRINTING STUDENT DATA FILE SUMMARIES.

INSERT DISKETTE FOR NEXT STUDENT.

PRESS SPACE BAR WHEN DISKETTE HAS BEEN INSERTED.

ESC KEY WILL EXIT THIS UTILITY."

8. Insert a student diskette in the upper disk drive, close the door, and press the space bar.

9. The student data from the files on the student diskette will be printed on the printer. When the student data summary has finished printing, the CRT will display:

"ARE THERE ANY MORE STUDENT DISKETTES?"

If there are more diskettes to be printed, type Y and repeat the above steps. Once all of the student diskettes have been printed, type N.

10. Type "6" to exit the utility program.

Copying Student Data to the Master Copy Diskette

Like any other new diskette, the master copy diskette must be zeroed before student data files can be copied to it. Follow the procedure under "Zeroing diskettes." Then initialize the diskette as outlined above, except, in response to "NEW FILE NAME?," type "MASTER:."

To copy the student data from the student diskettes onto the master copy diskette, perform the following steps:

1. Turn computer power on.

2. Place the UTILITY diskette in the lower disk drive and close the door. The utility program will start automatically.

3. Type 5. The CRT will display:

"UTILITY: COPY STUDENT FILES ONTO MASTER COPY DISKETTE.

INSERT MASTER COPY DISKETTE INTO LOWER DISK DRIVE.

PRESS SPACE BAR WHEN DISKETTE HAS BEEN INSERTED."

4. Remove the UTILITY diskette from the lower disk drive, replace it with the master copy diskette, close the drive door, and press the space bar. The CRT will now display:

"INSERT DISKETTE FOR NEXT STUDENT INTO UPPER DISK DRIVE.

PRESS SPACE BAR WHEN DISKETTE HAS BEEN INSERTED.

ESC KEY WILL EXIT THIS UTILITY."

5. Insert a student diskette into the upper disk drive, close the drive door, and press space. (However, if there are no more student diskettes to be copied to the master copy diskette, press ESC key to exit this utility function.) If a file for the student already exists on the master copy diskette, the CRT will display:

"A FILE FOR STUDENT NUMBER <number>, <student name>

ALREADY EXISTS ON THE MASTER COPY DISKETTE.

DO YOU WISH TO REMOVE THE EXISTING FILE?"

6. Type Y to remove the existing file for the student and to copy the file from the student diskette onto the master copy diskette. Type N if you do not wish to replace the files currently on the master copy diskette for this student.

7. If no file existed on the master copy diskette for the current student or if you answered Y in step 6, the student files on the current student diskette are copied onto the master copy diskette. The CRT will display the names of the new files on the master copy diskette as such:

"FILES FOR STUDENT NUMBER <number>, <student name>

COPIED TO THE FOLLOWING FILES ON MASTER COPY DISKETTE:

#4:STU<number>.<number>.HEADER

#4:STU<number>.<number>.DATA."

The suffix number is used as required to differentiate the files for different students with the same student number. The CRT will display:

"ARE THERE ANY MORE STUDENT DISKETTES TO BE

COPIED TO THE MASTER COPY DISKETTE? (Y/N)"

8. Type Y and repeat the above to copy more student data files. Type N when all diskettes have been copied. After typing N, the CRT will display:

"PUT UTILITY DISKETTE BACK INTO LOWER DISK DRIVE.

PRESS SPACE BAR WHEN DISKETTE HAS BEEN INSERTED."

9. Open the lower disk drive door, remove the master copy diskette, insert the UTILITY diskette, close the drive door, and press the space bar.

10. Type 6 to exit the utility program

11. Open the disk drive doors, remove the diskettes, and shut off the power.

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APPENDIX A

ALPHANUMERIC DATA BASE

FORMAT OF ALPHANUMERIC DATA BASE

DATA BASE ELEMENTS	DESCRIPTION
<number>;Number of actual scenes	Section 1 (Limit = 100 scenes)
<Name of the course....>	
/ Replaceable scenes (Annotation is not essential to the data base.)	
1: <Name of replaceable scene 1>	Section 2 starts here.
2: <name of replaceable scene 2>	(Limit = 100 scenes.)
3: <Name of replaceable scene 3>	
. .	
. .	
. .	
/ Initial complaints	
1: <Complaint 1>	Section 3
2: <Complaint 2>	
3: <Complaint 3>	
.	
.	
/ Switch list; # settings, default setting	
1: <switch name>	Section 4
*<setting name>	(The setting names are
<setting name>	identified and placed in
.	proper sequence. The default
.	setting is identified by an
2: <switch name>	asterisk. Limits = 127 sw's,
<setting name>	and 30 pos'ns per sw.)
.	
.	
.	
/ Test equipment names	
1: <Test equipment #1 name>	Section 5
2: <Test equipment #2 name>	(Limit = 10 TEs.)
3: <Test equipment #3 name>	
.	
.	
/ Test point names	
1: <Test point #1 name>	Section 6
2: <Test point #2 name>	(Limit = 254 TPs.)
3: <Test Point #3 name>	
.	
.	
/	

```
; Replaceable scene to scene number list
1: <scene number>                          Section 7
2: <scene number>                          (The identification number
3: <scene number>                          is the replaceable scene
   .                                       number from section 2.)
   .
/ Scenes for test equipments
1: <0 or scene number>                     Section 8
2: <0 or scene number>                     (The identification number is
3: <0 or scene number>                     the test equipment number.)
   .
   .
/List of test equip't by test p'ts
1: <test equip number(s)>                  Section 9
2: <test equip number(s)>                  (The identification number is
3: <test equip number(s)>                  the test point number from
   .                                       section 6.  Test equip numbers
   .                                       must be separated by one or
   .                                       more spaces.)
   .
/Problem data; replaceable scene, initial complaint.
1: <repl. scene> <initial compl.>          Section 10
2: <repl. scene> <initial compl.>          (The identification number is
3: <repl. scene> <initial compl.>          a problem number. Separate
   .                                       replaceable scene from the
   .                                       complaint number by one or
   .                                       more spaces. Limit = 99 prob.)
   .
/ Problem data; initial switch settings
1: <sw. number> <initial setting>          Section 11
   <sw. number> <initial setting>          (Each problem may have one or
   .                                       more specific switch settings,
2: 0 0                                     or none, but each must be
3: <sw. number> <initial setting>          listed.)
4: <sw. number> <initial setting>
   <sw. number> <initial setting>
   .
   .
/
```

```
; Conditions; switch #, settings.
1: <sw. number> <setting(s)>
   <sw. number> <setting(s)>
   .
2: <sw. number> <setting(s)>
3: <sw. number> <setting(s)>
   <sw. number> <setting(s)>
   .
   .
   .
   .
   .
/ Replacement and prerequisite conditions
0: <replacement condition>
1: <prerequisite condition>
2: <prerequisite condition>
3: <prerequisite condition>
   .
   .
   .
   .
   .
   .
/  Sections 1 to 13 are input to RTDATA1.TEXT on the DATA diskette,
;  and sections 14 to 17 are input to RTDATA2.DATA.
;
;Picture data
1.0: *101
       1
       0
     .
     .
     .
     .
     .
22.0: *<picture number>
      <number of conditions>
      <sufficiency condition>
      <1st mode condition>
      <2nd mode condition>


     *<picture number>
      <number of conditions>
      <sufficiency condition>
      <1st mode condition>
      .
      .
```

Section 12
(Conditions are required sw. setting(s) for one or more switches. Switch numbers and setting numbers are separated by space(s). The settings for switches not listed do not affect the condition. Limits = 1200 conditions, 10,000 lines of data.)

Section 13
(The replacement may be 0, any condition, or any condition selected from section 12. Prerequisite condition identification numbers are replaceable scene numbers from section 2. Each replaceable scene must be listed.)

Section 14
('Scene 1' is always the top level scene, has only one condition, 0, any condition. Limits = 1000 lines of data in a normal block, 100 abnormal blocks per scene, 500 lines in an abnormal block.)

(Normal data for scene 22. Picture numbers must be preceded by an asterisk and must be followed by the number of conditions to be evaluated. If the sufficiency condition is true, the mode conditions will be evaluated. Otherwise, the computer will jump to the next picture number.)

```
.
.
22.1: *<picture number>                    (Pictures for first abnormal
      <number of conditions>               block, scene 22)
      <sufficiency condition>
      <1st mode condition>
      .
      .
/
22.2: *<picture number>                    (Pictures for 2nd abnormal
      .                                    block, scene 22)
      .
23.0: *<picture number>                    (Reminder: picture numbers
     .                                     are fiche plus image numbers.
     .                                     Picture 2943 is thus the 43rd
     .                                     image on fiche 29, is the 7th
     .                                     image on the 4th row.)
/ Problem data; failed scene and block data
1: <scene number> <block number>           Section 15
   <scene number> <block number>           (Identification by prob. no.
   <scene number> <block number>           Each scene which contains
   .                                       abnormal indications must be
   .                                       shown. Data for scenes not
2: <scene number> <block number>           listed is normal data.)
   <scene number> <block number>
   .   .
   .   .
/ Picture data for test equipment readings
1.0: #<test equipment number>               Section 16
      *<picture number>                    (Limits = 150 lines per block.
       <number of conditions>              Identification is test point.
       <sufficiency condition>             Note similarity to section 14.
       <1st mode condition>                Major difference is inclusion
       <2nd mode condition>                of test equipment numbers.)
       .
      *<picture number>
       1                                   (One condition only for this
       <sufficiency condition>             picture. Default for this TP)
     #<test equipment number>              (2nd piece of test equipment)
      *<picture number>
       <number of conditions>
       <sufficiency condition>
       <1st mode condition>
       .
       .
       .
```

```
.
.
1.1: #<test equipment number>          (First block of abnormal data)
      *<picture number>
       <number of conditions>
       <sufficiency condition>         (Note that if none of these
       .                               pictures can be shown, the
       .                               computer will go to the normal
       .                               data.)
2.0: #<test equipment number>
       .
       .                               (Include data for EVERY test
       .                               point.)
       .
/Problem data; abnormal test point data
1: <test point> <block>                Section 17
   <test point> <block>
     .
     .                                 (Identifies whether there are
     .                                 abnormal data for the problem,
2: <test point> <block>                or whether to look at normal
   <test point> <block>                data.)
   .
   .
/ This slash ends the data base
```

EXCERPTS FROM AN/WSC-3 (ECHO) DATA BASE

```
83; Number of Scenes
WSC-3(E) Satellite Communications Systems; name of data base
/Replaceable Scenes; section 2
 1:1A1A1 Radio XMTR
 2:1A1A2 Pwr Supply; Volt. Reg.
 3:1A1A3 RCV Phase
      .
      .
 21:1A2J8 WSC-3 BACK RF CONN  ; 21 replaceable scenes.
/Initial Complaints; section 3
 1:  Malfunction light is on.
 2:  Malfunction light stays on in standby.
 3:  Transmitter will not key.
 4:  FM inoperative.
      .
      .
 11: Will not transmit in PSK 75 or FSK  ; 11 complaints, but 12 problems.
/Switch list
 1: Local Modulation Sw.
    75PSK
    300PSK
    1200PSK
    2400PSK
    4800PSK
    9600PSK
    FM
   *AM
 2: Local Xmtr Key Sw.
    ON
   *OFF
      .
      .
31: Ships Heading  ; 31 switches.
      .
/Test Equipment Names; section 5
 1: Oscilloscope
 2: Multimeter-DC VOLTS
 3: Multimeter-OHMS
 4: Frequency Counter  ; 4 TE's.
/Test Point Names; section 6
 1:1A1A1 J1
 2:1A1A1 J2
 3:1A1A1 J3
      .
      .
 245:1A2 J5  ; 245 TP's.
/
```

```
; Replaceable Scene to Scene List; section 7
 1:40
 2:41
 3:42
    .
    .
 21:60
/ Test Equipment Scenes; section 8
 1:0
 2:0
 3:0
 4:0  ; none adjustable.
/Test Equip. that can be used for Test Points; section 9
 1:1 2
 2:1 2
 3:1 2
    .
    .
 245:4
/Problem Data: Problem Number, Failed scene, Initial Complaint; section 10
 1: 2 1
 2:11 2
 3:20 3
    .
    .
/Problem data: Problem, switch & setting if other then default; section 11
 1: 0 0
 2: 0 0
     .
     .
 12:0 0
/ Basic Conditions; section 12
 1: 9 2; lights off
   10 2; switches off
 2: 9 2; standby light off
   10 1; power light off
 3: 9 1; Power light on
   10 2; Standby light on
    .
    .
 834:7 1  ; 834 conditions, this one covering 7 switches.
   15 2
   22 1
   23 1
   25 1
   26 1
   27 2 3
   31 1 2
/
```

```
; Conditions Necessary to see Each Scene; section 13
 0:1 ; Replacement condition
 1:0
 2:0
 3:0
   .
   .
 83:0  ; must list all scenes.
/ NOTICE: This is the end of RTDATA1.TEXT. RTDATA2.TEXT starts
; with section 14.
; Picture data; scene, block, image no. (picture)...section 14
 1.0:*101
        1
        0 ;  sufficiency condition = any condition.
 2.0:*113
        1
        9
     *114
        1
       10
     *115
        1
       11
     *116
        1
       12
     *117
        1
       13
        .
        .
 83.0:*1743
          1
          0
/Abnormal Scenes and Blocks for Each Problem
 1: 6 1
    7 1
   14 1
   15 1
   18 1
   19 1
   21 1
   24 1
   25 1
 2:6 2
    .
    .
 12:18 5
/
```

```
;Test Point Picture Information
 1.0:#1   ; normal data for TP 1, TE 1 (oscilloscope).
   *1005
       9
     652
     653
     654
     655
     656
     661
     663
     665
     666
   *1004
       1
       4
   *1016
       1
       0
   #2
   *1023
       5
     652
     653
     654
     655
     656
   *1022
       1
       4
   *1028
       1
       0
 1.1:#1    ; abnormal data for TP 1.
   *1016
       1
       0
   #2
   *1028
       1
       0
    .
    .
 28.0:#1; J15
    *1140
        1
        4
```

```
   *1156   ; 2nd picture image, TP 28, normal data.
      1
     38
   *1159
      1
      0
   #2
   *1115
      1
      4
   *1123
      1
     38
   *1126
      1
      0
28.1: #1
   *1153
      1
      4
   #2
   *1120
   *1221
      .
      .
245.0: #4; 1A2 J5
       *1711
          1
          4
       *1703
          1
          0
 / Problem data; abnormal TP's and TP blocks.
 1: 1 1
    2 1
    3 1
    .
    .
 12: 56 1
     157 1
     162 1
     223 1
  / END OF DATA
```

APPENDIX B

PREPROCESSOR MESSAGES

PREPROCESSOR MESSAGES

The preprocessor program attempts to locate as many data base errors as it can in the process of turning the text files RTDATA1.TEXT and RTDATA2.TEXT into the data file RTDATA.DATA. Whenever it finds an error, it writes a message to both the CRT and the disk file ERRORS.TEXT. The text file ERRORS.TEXT can be read in edit mode or can be printed to get a hard copy of the data base errors, if necessary.

Each error message begins with "LINE XX:," where XX is the number of the line in the data base containing the error, followed by a message indicating the type of error. Line numbers are continuous from RTDATA1.TEXT through RTDATA2.TEXT. The line of the data base follows immediately after the error message. For example,

```
LINE 679:    ILLEGAL CHARACTER IN NUMERIC DATA
476:    9 2A
```

will be printed when the above line is encountered while processing condition data, because it contains a letter where a number is expected.

The messages that can be generated by the preprocessor, along with a brief explanation of each, follows:

1. IDENTIFIER OUT OF SEQUENCE. This message is generated when the number assigned to an identifier in a section of the data base is not exactly one more than the number assigned to the immediately preceding identifier or when the first identifier in the section is not 1. This error often indicates that an identifier has been omitted. Note that, even when there are no relevant data to be included in subordinate sections of the data base, an identifier must be listed, with dummy data values (such as zero) associated with it.

2. UNEXPECTED END OF FILE. This message indicates that the end of RTDATA1.TEXT or RTDATA2.TEXT has been encountered before all of the sections of the data that the test file is supposed to include have been processed. This error is often caused by the omission of the slash that must follow the last section of data.

3. ILLEGAL CHARACTER IN NUMERIC DATA. This message indicates that a character other than one of the digits 0 to 9 was encountered in the data when the preprocessor was expecting a number. A nonprinting character entered by mistake, such as a control character, will cause this message. If this message is presented for a line that appears to contain only legal numeric characters, delete the entire line and retype it.

4. SCENE NUMBER TOO LARGE. This message indicates that a scene number greater than the number of defined scenes (the first number in the data base) has been used in the data base.

5. NUMBER OF ITEMS MUST MATCH NUMBER OF CORRESPONDING NAMES. This message indicates that the number that is the last identifier in a section of data does not match the last identifier in the section containing the corresponding names (Sections 2, 4, 5, and 6, for example).

6. SETTING NUMBER EXCEEDS NUMBER OF POSSIBLE SETTINGS. This message indicates that a setting number for a switch is greater than the number of settings defined for that switch in Section 4.

7. COMPLAINT NUMBER TOO LARGE. This message indicates that a complaint number defined as the initial complaint for a problem in Section 10 is greater than the number of complaints defined in Section 3.

8. SWITCH NUMBER TOO LARGE. This message indicates that a switch number appearing in Section 11 or Section 12 is greater than the number of switches identified in Section 4.

9. INCORRECT NUMBER OF PROBLEMS. This message indicates that the last identifier in Sections 11, 15, or 17 does not match the number of problems defined in Section 10.

10. NUMBER OF SCENES TOO LARGE OR NOT A VALID NUMBER. This message indicates that the first number in the data base is either greater than the maximum allowable number of scenes or contains a nonnumeric character.

11. NUMBER FIELD CONTAINS ONLY BLANKS. This message indicates that a portion of a line wherein a number is expected contains only blanks.

12. TEST EQUIPMENT NUMBER TOO LARGE. This message indicates that a test equipment number in either Section 9 or Section 16 is greater than the number of test equipments defined by the last identifier in Section 6.

13. CONDITION NUMBER TOO LARGE. This message indicates that a condition number in Section 12 is greater than the maximum permissible number of conditions or that a condition number in Section 14 or 16 is greater than the number of conditions defined in Section 12.

14. INCORRECT NUMBER OF SCENES. This message indicates that the last identifier in Section 13 or the scene number part of the last identifier in Section 14 does not match the number of scenes defined in Section 1.

15. BLOCK NUMBER OUT OF SEQUENCE. This message indicates that the first block number of a scene in Section 14 or Section 16 is not "0," or that a block number for a particular scene is not exactly one more than the previous block number for that scene.

16. FICHE NUMBER (OR PICTURE NUMBER) ZERO OR TOO LARGE. This message indicates that the fiche number designated in Section 14 or 16 is either zero or greater than the maximum permissible fiche number (30).

17. IMAGE NUMBER ZERO OR TOO LARGE. This message indicates that the image number portion or a picture number is either zero or greater than the maximum possible image number (60).

18. TEST POINT NUMBER TOO LARGE. This message indicates that a test point number in Secton 17 is greater than the number of test points, as defined by the last identifier in Section 6.

19. MAXIMUM NUMBER OF NAMES EXCEEDED. This message indicates that the number of named items (Sections 2 - 6) is greater than the specified length of the index to the names (300).

20. MAXIMUM NUMBER OF SWITCHES EXCEEDED. This message indicates that an identifier in Section 4 is greater than the maximum permissible switch number.

21. MAXIMUM NUMBER OF PROBLEMS EXCEEDED. This number indicates that a problem number identifier in Sections 10, 11, 15, or 17 is greater than the maximum permissible number.

22. PICTURE NUMBER (PRECEDED BY *) IS EXPECTED. This message indicates that the number encountered when a picture number is expected is not preceded by an asterisk. A picture number is expected as the first number following each scene identifier in Section 14 and as the first number following each test equipment number in Section 16. It is also expected when the number of conditions specified for a previous picture in these same sections has already been read.

23. TEST EQUIPMENT NUMBER (PRECEDED BY #) IS EXPECTED. This message indicates that a number immediately preceded by a number sign (#) was not encountered when a test equipment number was expected (i.e., as the first number following each block identifier in Section 16).

24. CONDITION NUMBER EXPECTED. This message indicates that a picture number or a test equipment number was encountered when a condition number was expected. The number of conditions to be evaluated is specified for each picture and must match the number of conditions actually presented.

25. NUMBER OF CONDITIONS DOES NOT MATCH COUNT. This message indicates that the number of conditions for a picture in either Section 14 or 16 does not match the condition count specified. The usual case here is that either too many conditions are included or the number specified is too small.

26. CONDITION COUNT IS ZERO. This message indicates that the number on a line immediately following a picture number is zero. The usual case is that the condition count for a picture that was to be shown in any condition (condition number = 0) was omitted. The number of conditions to be read must always be specified, even for pictures that are to be shown under any condition.

27. CONDITION DATA TOO LONG. This message indicates that the total number of lines of condition data exceeds the maximum possible number. The number of lines must be reduced to fall within the specified limit. Frequently, redundant or nearly redundant conditions can be eliminated, or conditions containing many switches and switch settings can be reduced in size.

28. BLOCK NUMBER ZERO OR TOO LARGE. This message indicates that a block number in Section 15 or 17, which should reference only malfunction data, is either zero or is greater than the largest block that was defined for the scene data in section 14 or for the test point data in Section 16.

APPENDIX C

LIST OF CRT MESSAGES

CRT MESSAGES

1. YOU HAVE FINISHED ALL OF THE PROBLEMS AVAILABLE FOR TODAY'S SESSION. CALL YOUR INSTRUCTOR. This message is displayed when the student has completed all of the required problems in the limiting pool. This ensures that the student does not do any problems beyond those for which he is prepared.

2. YOU HAVE FINISHED THE COURSE. CALL YOUR INSTRUCTOR. This message is displayed when the student has completed all of the required practice and test problems. He has finished the course and there are no more problems to be assigned.

3. YOU HAVE COMPLETED THE PRACTICE PROBLEMS. DO YOU WISH TO PROCEED WITH THE TEST AT THIS TIME? This message is displayed to warn the student that the next problem is a test. If the student decides he is not prepared for a test problem, he may quit the session.

4. THAT SCENE CANNOT BE VIEWED IN THE CURRENT SWITCH CONFIGURATION. Since there are so many possible switch configurations, not all may have been accounted for in the data base. This message is a safeguard in case the student tries to view a scene for which there isn't a currently applicable picture. It can also be used to "lock out" a scene that requires a switch to be in a specific position(s).

5. THE PICTURE SHOWING DOES NOT REPRESENT A TEST EQUIPMENT READING. This message is displayed if the student asks for interpretations of a T/E READING when the picture on the display screen is not a test equipment reading.

6. <SCENE NAME> HAS BEEN REPLACED. This message informs the student that the requested replacement has been made.

7. THE ELEMENT BEING DISPLAYED IS NOT REPLACEABLE. This message is displayed when the student tries to replace a nonreplaceable unit or module.

8. REPLACEMENT IS NOT PERMITTED UNTIL THE SYSTEM IS PROPERLY DEENERGIZED. This message is displayed when the student tries to replace a scene while the system is still powered.

9. THE CURRENT PIECE OF TEST EQUIPMENT CANNOT BE CONNECTED TO THAT TEST POINT. This message informs the student that the selected test equipment cannot be connected to the current test point.

10. THERE IS NOTHING TO POINT TO ON THIS PICTURE. This message informs the student that there are no touch points defined in this scene.

11. INVALID TOUCH. PLEASE TRY AGAIN. This message informs the student that his last touch was not to a defined touch point.

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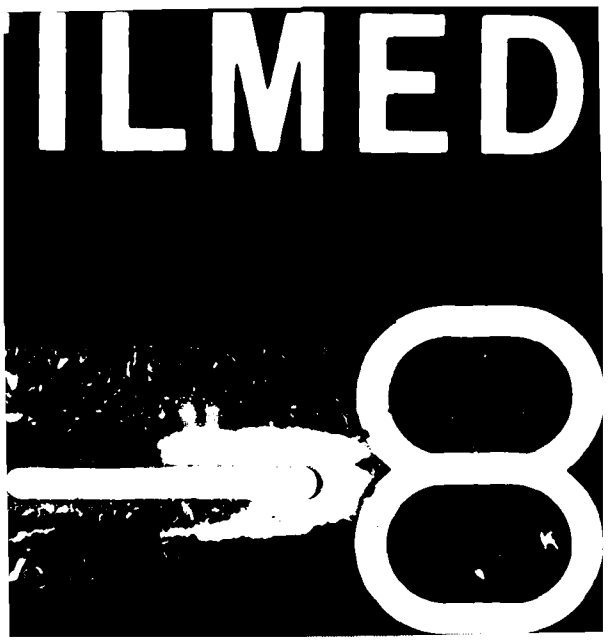
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